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Project 3.20 (U)

(6) BLAST AND THERMAL EFFECTS OF AN ATOMIC BOMB ON TYPICAL TACTICAL COMMUNICATION SYSTEMS [U], (8)

(10) by Jacob Eggert and

Elmer R. Higgins.

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ABSTRACT

The objective of UPSHOT-KNOTHOLE Project 3.20 was to determine the effects of air burst nuclear weapons on selected items of signal communication equipment.

Typical items of this equipment, such as would be found in a communications zone or field army area, were oriented in test groups at varying distances from GZ to obtain an anticipated damage spread from severe to negligible. Participation in Shot 9 consisted of 93 such test groups. Participation in Shot 10 was limited to 17 test groups because of shortage of funds, materiel, and labor. Photographic records of damage, and evaluations of the levels of damage, were made by project personnel.

The anticipated spread from neglibible to severe damage was obtained for the majority of the test groups. Recorded values, and predicted values (from TM23-200), for thermal flux, peak overpressures, and initial gamma radiation were in close agreement in both Shots 9 and 10. The damage from Shot 9 was about what was expected. However, the damage from Shot 10 was greater than can be attributed to known effects. Presumably, reports of other projects concerned with such phenomena will evaluate these effects, which are important, but beyond the scope of this project.

The recorded data led to the following general conclusions:

a. The principle causes of damage were, in order of importance:

(1) Peak drag pressure (dynamic pressure), including secondary damage from debris in motion. Peak overpressure may also be considered a valid measure of blast effectiveness against this equipment, except in the precursor region of low burst weapons where no known relation exists between peak drag pressures and peak overpressures.

(2) Thermal flux.

(3) Radiation.

b. Damage to this equipment varies in accordance with accepted criteria in TM 23-200.

c. Damage criteria as presented in this report can be used as a basis for augmenting effects information in TM 23-200 and other applicable publications.

d. Orientation of equipment and facilities is of significant importance in minimizing damage.

e. The possibility of using laboratory methods to determine thermal and overpressure effects on this equipment should be investigated.

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PREFACE

The purpose of Signal Corps participation in Project 3.20 was to determine the amounts of thermal flux (cal) and peak overpressure (psi) required to cause severe, moderate, light, and negligible damage to selected signal communications-electronics items of equipment and material for which inadequate or no data existed. Knowing these factors it is believed that responsible signal officers can better plan their tactical communications systems and take passive protective measures to reduce damage and losses to acceptable minimums. These data will also be used to improve design of equipment and material.

Shot 9 was a relatively high air burst air delivered bomb. Shot 10 was a relatively low air burst weapon delivered by the Army 280 mm gun.

In this report, the letters "cal." are used to indicate total thermal flux (cal/cm^2). The /cm^2 portion of the expression has been dropped because of the many times the expression for thermal flux appears, to facilitate typing and for simplification when expressed orally. The letters "psi" are used to indicate air blast peak overpressure on the surface.

In general thermal flux values are mentioned first followed by peak overpressure figures. This was done solely because of the fact that the thermal effects actually preceded those of the blast and this method of association appears to be a logical one.

Horizontal distances rather than slant ranges have been used in this report on all effects parameters for clarity. Their use should not be misunderstood. The distances cited hold only for these tests. These distances will vary for each atomic weapon yield burst at a different height under differing conditions of atmosphere and terrain. However, wherever a certain amount of thermal flux, peak overpressure, or gamma radiation exists one can expect approximately the equivalent degree of damage to be received.

The calculated and recorded thermal flux, peak overpressures, and gamma radiation figures for both Shots 9 and 10 are in close agreement; however, the results obtained in Shot 10 indicate that the blast damage was greater than that which can be attributed to peak overpressure effects alone. It is not known at this time what caused this greater damage nor is it considered to be within the scope of this project to determine the cause.

The Shot 9 recorded thermal flux figures (cal) are considered accurate to ± 10 per cent; peak overpressures (psi) ± 10 per cent, and gamma radiation figures ± 10 per cent.

The Shot 10 thermal flux figures are considered accurate to ± 10 per cent; peak overpressures (psi) ± 10 per cent, and gamma radiation figures ± 10 per cent.

The horizontal distances from ground zero to which damage extends for both Shots 9 and 10 have been estimated to the nearest 25 ft. The horizontal distances to which the thermal flux, blast, and gamma radiation extend are applicable only for the heights of burst and for the yields used. For other yields and different heights of burst it is necessary to refer to scaling laws, (reference TM 23-200).

In subsequent paragraphs of this chapter test groups for both Shots 9 and 10, (where used), have been combined into logical groupments. A detailed explanation of the design of the experiment is considered followed by the results obtained, ending each groupment with pre- and postshot photographs for both Shots 9 and 10. No suffix to a test group indicates that it was in Shot 9. Test Groups with the suffix A indicates that the test group was in Shot 10. This manner of treatment of the problem was made to provide close continuity.

FOREWORD

This report is one of the reports presenting the results of the 78 projects participating in the Military Effects Tests Program of Operation UPSHOT-KNOTHOLE, which included 11 test detonations. For readers interested in other pertinent test information, reference is made to WT-782, Summary Report of the Technical Director, Military Effects Program. This summary report includes the following information of possible general interest.

a. An over-all description of each detonation, including yield, height of burst, ground zero location, time of detonation, ambient atmospheric conditions at detonation, etc., for the 11 shots.

b. Compilation and correlation of all project results on the basic measurements of blast and shock, thermal radiation, and nuclear radiation.

c. Compilation and correlation of the various project results on weapons effects.

d. A summary of each project, including objectives and results.

e. A complete listing of all reports covering the Military Effects Tests Program.

ACKNOWLEDGMENTS

The Sixth Army Area Signal Officer, Col A. B. Cooper, provided Signal support from the 16th Signal Service Battalion (corps), Detachment A. This detachment in the command of Brig Gen William Bullock, Commanding General, Camp Desert Rock, CP Desert Rock, Nevada, was commanded by the Signal Officer, Camp Desert Rock, Lt Col H. H. Heynen. Detachment A rendered excellent logistical support and essentially all of the construction effort was performed by this detachment. It is desired to acknowledge the assistance and cooperation of all the officers and enlisted men who contributed to the project.

The 412th Engineer Battalion, Camp Desert Rock, assisted immeasurably to the success of this project. This effort is acknowledged with appreciation.

It is desired to acknowledge the manner in which the U. S. Air Force, Lookout Mountain Laboratory, Col James Gaylord, provided pre- and post shot motion picture coverage for this project, and the splendid cooperation of the assigned Lookout Mountain Laboratory personnel.

The Corps of Engineers, the Medical Corps and the Ordnance Corps permitted signal items to be displayed in their installations and vehicles where it did not interfere with their projects. This coordination resulted in savings in construction effort, time, and funds. Appreciation is acknowledged.

This project could not have achieved full value without adequate photographic coverage prior to, during, and after the shot. Of equal value are the peak overpressure, thermal flux, gamma radiation and other data of a technical and scientific nature. The efforts of those engaged in this work are appreciated and their endeavours have provided valuable data in association with the project objectives.

The cooperation and assistance of the Commanding General, Field Command AFSWP, and the entire staff engaged in providing housekeeping facilities, and most helpful technical assistance, is appreciated.

The Technical and Administrative assistance from the Office of the Chief Signal Officer, Engineering and Technical Division; Headquarters AFSWP, Washington, D. C.; and the Signal Corps Board, Fort Monmouth, New Jersey, was most helpful to the project and is acknowledged.

Personnel from the Coles Signal Laboratory, Fort Monmouth, assigned to the project at the Nevada Proving Grounds worked tirelessly and for long hours, frequently under severe wind and dust conditions at the test site, in order to accomplish the assigned mission. Their efforts contributed substantially to the success of the project and are appreciated.

There are many others who rendered invaluable assistance. It is not possible to acknowledge all of the individual contributions. Their interest in this project is sincerely appreciated.

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CHAPTER 1

OBJECTIVES

1.1 GENERAL

The major objective of this project was to subject selected signal communications-electronics items of equipment and material to air burst atomic weapons to determine the effects thereon. The effects data obtained, together with data made available from other atomic tests, may be used in the preparation of a suitable guide for Signal and Communication Officers in planning tactical and nontactical communications installations and facilities in atomic warfare. These data can also be used in conjunction with data made available from previous atomic tests in the continuing improvement, development, and design of signal communications-electronics equipment and material.

The effects data derived from this test are available for study and evaluation in preparing damage criteria tables for TM 23-200, Capabilities of Atomic Weapons.

CHAPTER 2

BACKGROUND, INSTRUMENTATION AND EXPERIMENTAL PLAN

2.1 BACKGROUND

The Signal Corps, U. S. Army, has participated in all atomic weapons tests since 1945. However, this participation has been principally concerned with instrumentation and communications support rather than with the effects of atomic weapons upon signal communications-electronics equipment and material.

An examination of much of the data made available from previous atomic tests reveals that it is limited in scope. In many instances extrapolation has been necessary to estimate tactical effects. In other instances there are no representative data available.

In the Bikini test, selected items of signal communications-electronics equipment were installed in naval vessels and tested. Since the equipment was firmly fastened to the decks of these vessels the conditions of the test were not representative of those which would have obtained in any army tactical situation. Also, the equipment may have been affected by shielding or shadow effects. The Hiroshima and Nagasaki air drops provided some data on signal communications-electronics equipment and material, but these data were not complete.

That portion of Exercise Desert Rock I involving signal communications-electronics equipment and material represented the first planned tactical effects tests for these items. The data obtained from this exercise were still insufficient. Also no signal equipment was tested for the effects of an air burst weapon closer than 1020 yd from ground zero (GZ). Effects data secured in this test were through the Department of the Army troop participation program.

An examination of test reports and Department of the Army interim tactical doctrine as late as November, 1952, reveals that, "presently available data of atomic missile effects on tactical dispositions are inadequate." From the results of Desert Rock I exercise, Major General W. B. Kean in his report stated, "Further tests are required to:

1. Corroborate and validate the findings and conclusions presented herein.

2. Determine damage effects to military equipment, material and ammunition for nuclear explosions of different magnitudes and character."

The Signal Corps Board, an agency of the Chief Signal Officer, U. S. Army, has conducted a series of studies to determine the influence of atomic weapons upon signal communications-electronics in division, corps and Army areas, and is presently conducting a study for the communications zone. These studies conclude that "atomic weapons effects data are not fully adequate," and it was recommended in these studies that "The Engineering and Technical Division, Office of the Chief Signal Officer, the Signal Corps Engineering Laboratories, and other interested agencies actively participate in atomic tests such as UPSHOT-KNOTHOLE, to the end that adequate data may be secured for inclusion in TM 23-200, Capabilities of Atomic Weapons, and other appropriate publications."

Eight Signal Corps Engineering Laboratories personnel, including the project officer and assistant project officer (assigned to the project from the Signal Corps Board), were assigned to the project. All laboratory personnel were quartered at Camp Mercury, Nevada and operated from space in a quonset hut assigned to Program 3, and allocated to Project 3.20 (Fig. 2.1). A functional chart of the board categories of equipment and material tested in Project 3.20 is shown in Fig. 2.2.

The installation and construction effort for the project was performed essentially by enlisted personnel from the 16th Signal Battalion (Corps) Detachment A, Camp Desert Rock, under the technical supervision of Signal Corps Engineering Laboratories personnel.

It was necessary to keep the original test plan very flexible up to the time of the test. This flexibility was dictated by allocation and reallocation of test site space, date of arrival of equipment in some instances, and fluctuating availability of installation and construction personnel. Many more signal items could have been tested. However, it was desirable not to display more test items than could properly be analyzed during the short time interval between Shots 9 and 10. This short period of time (a total of two weeks), coupled with limited availability of personnel also dictated the limited construction effort which could be devoted to Shot 10.

Dust conditions which prevailed at the test site forced curtailment of all activity at the test site of an average of from one to two working days each week. The temperature at the test site, though seasonably hot on several days, was never excessive.

After arrival at the test site it was learned that certain areas were to be dust stabilized for photographic purposes by spreading a light concrete coating on the surface. This process was utilized to assure better high speed photography during the blast. Endeavors were made to have several of the Project 3.20 areas stabilized. Only one area was partially stabilized however (Test Group 24, the area including poles C-8 and C-7, 3425 ft from GZ). Further stabilization of Project 3.20 areas could not be undertaken because all available funds for this purpose had previously been committed.

Following completion of damage analysis, equipment and material were salvaged, destroyed, returned to depots for re-use, or returned to the laboratories for further tests.

Vehicles and personnel, after roll-up, completion of the approval of the preliminary report, returned to their home stations.

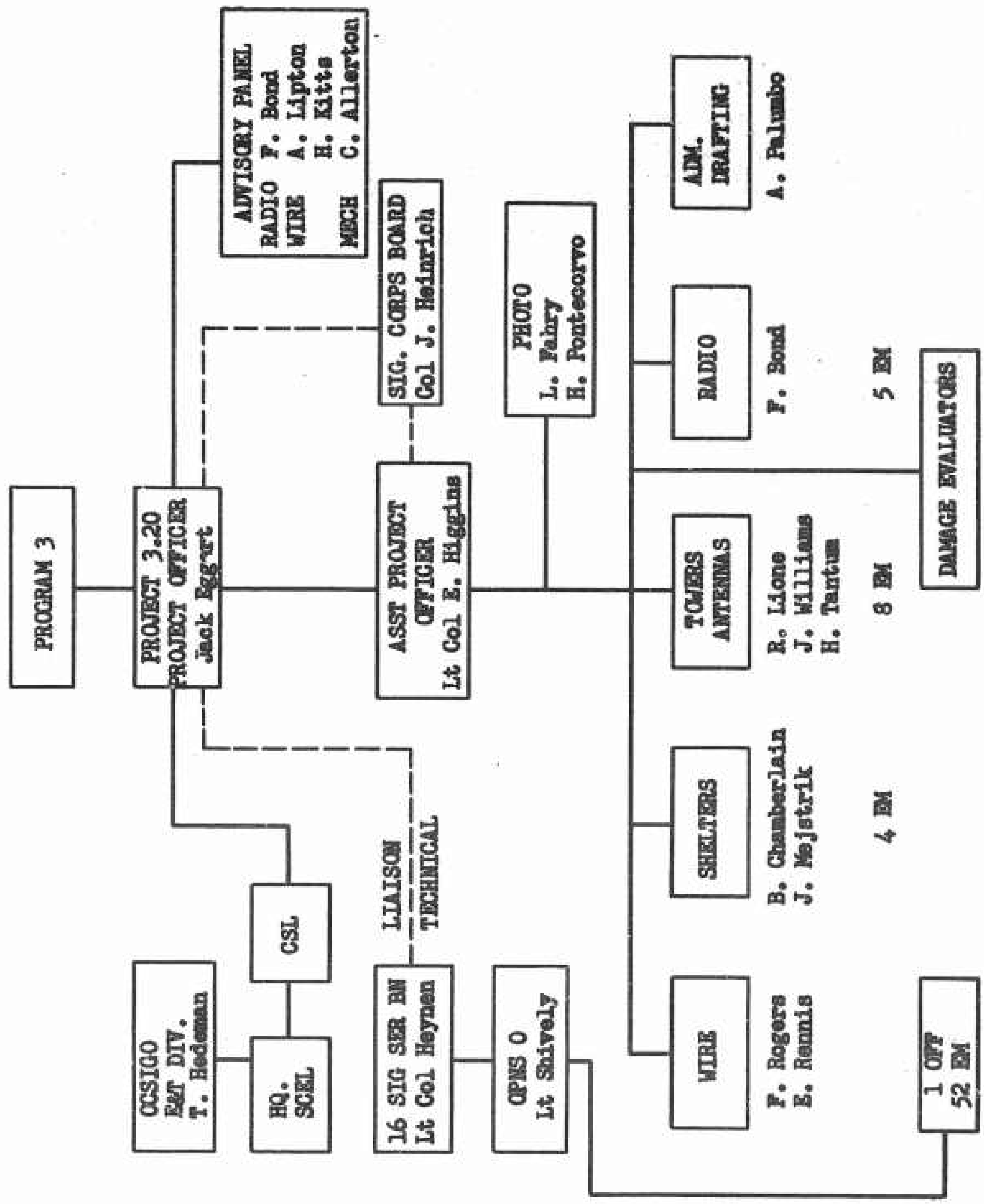


Fig. 2.1 Organization, Project 3.20

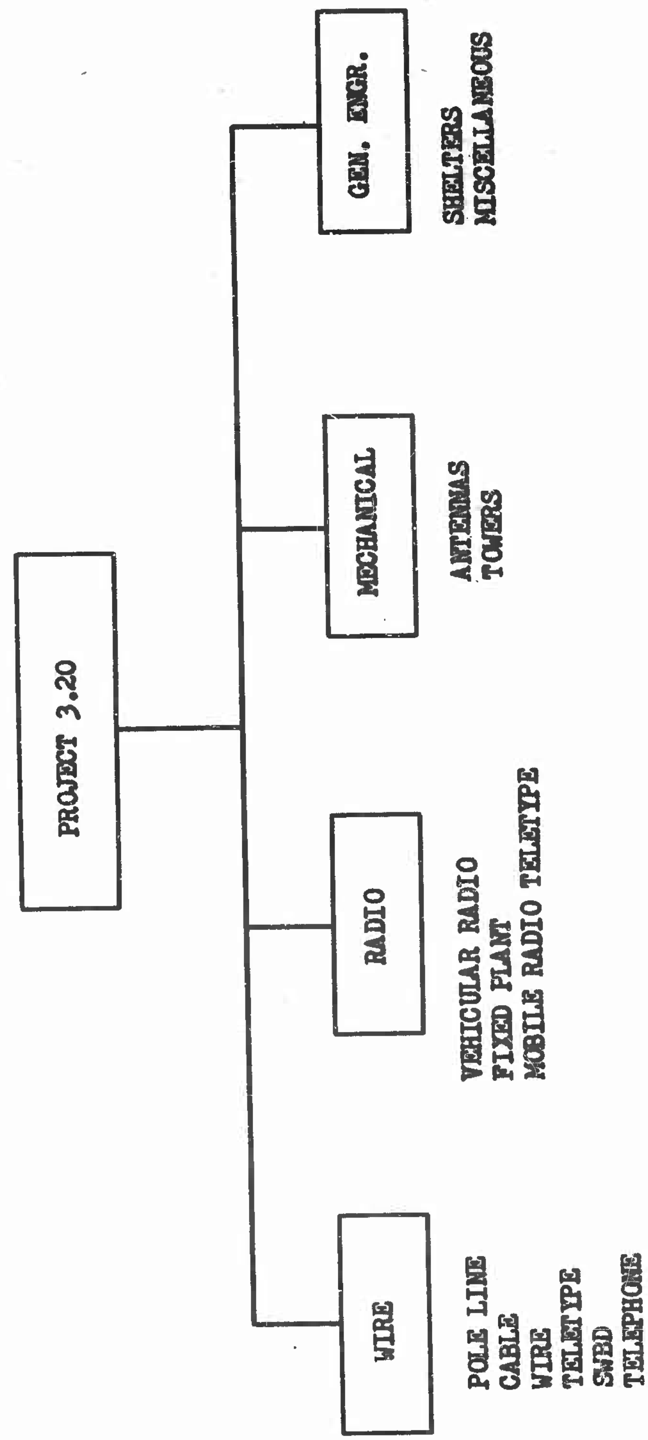


Fig. 2.2 Categories of Equipment and Material Tested

2.2 INSTRUMENTATION

These tests were tactical and engineering in nature. The test groups and test items were not scientifically instrumented. Thermal flux peak overpressure, gamma radiation, and technical and scientific data, other than those data obtained from film badges, were obtained from the Naval Ordnance Laboratory and the Signal Corps Engineering Laboratories (Evans Signal Laboratory). Full development of the test results obtained in the above-mentioned projects appear in the final reports of the various projects. Initial results are recorded in preliminary reports. Copies of the various curves were secured from the Technical Director and, though not normally included in reports such as this, are included in the Appendices. The reason for their inclusion is that they are considered essential to proper analysis and interpretation of the results.

In Shot 9, power units PE-95 and radio receivers were in operation at the time of the blast. The power units were replenished with gasoline and fresh batteries and with one exception were started up subsequent to the blast. No power units were used in Shot 10.

Resistance and voice tests were made on all wire channels prior to and subsequent to both shots. Tests regulations limited the use of electromagnetic radiations during the shots therefore the transmitters were not placed on the air. The filaments of vacuum tubes employed in transmitters and receivers were operative during Shot 9.

Still photography (black and white, color, and stereotype), manually secured motion picture photography (black and white and color), and high speed, fixed platform, electrically initiated motion picture photography taken during the shots were furnished by Program 9. Limited high speed, photographic coverage of Project 3.20 was secured during the shots. However, an examination of the film for other projects reveal action on Project 3.20 items of interest. High speed action was secured during Shot 9 for the large towers, Test Groups 33, 34, 35, and 36; Test Group 24, the transverse open wire pole line; Test Group 1, the radial pole line; Test Group 81, the AN/GRC-9 and the AN/GRC-26 radios in an Ordnance Corps 2½ ton truck and ¼ ton jeep; and Test Group 101, the two dummies in a foxhole at 1725 ft with AN/PRC-6 and AN/PRC-10 radio sets. A study of these action photographs reveals information that could not otherwise be obtained. High speed action photography was not available for Shot 10.

A number of the other effects test projects were instrumented with various types of gages and meters. Data from these projects can be applied to signal communications-electronics items. For example, in the Forest Service Project 3.19, there was a 75 ft telephone pole, and numerous trees, which were instrumented for compression and drag. Mention is made of these projects to remind the reader that certain types of signal items were not tested because similar items were tested and instrumented in other projects. These results external to the 3.20 project are important factors in determining whether or not further effects tests are required for similar signal items in the future.

Postshot electrical and materials tests were not conducted at the test site because of lack of personnel and proper facilities. Items of interest were returned to the laboratories and have received tests equivalent to testing at the site.

2.3 EXPERIMENTAL PLAN - SHOT 9

In laying out the experimental plan, conferences were held with experienced Signal Corps officers and consultants, some of whom had participated in previous atomic weapons tests. In addition, reference was made to many of the documents and publications contained in the Bibliography, Appendix H. Predicted thermal energy and peak overpressures calculations were made from data contained in TM 23-200, Capabilities of Atomic Weapons. Not having had the expected yield or height of burst figures available to the project at the time the test plan was originally prepared, a yield of 30 KT and height of burst of 2400 ft was assumed for Shot 9. It was considered that these parameters would have been appropriate for a division or corps area. Estimates for Shot 10 were available to project personnel prior to the shot.

The radial pole line was designed to determine radial thrust and bending effects. The transverse pole lines were designed to determine the differences, if any, in forces operating normal to the pole lines as compared to forces acting along the radial pole line. Photographic coverage of the pole lines was desired during the shots to observe their behavior.

The surface and underground wire and cable lays were designed to acertain the blast and heat protection afforded at the surface and at various depths of earth cover.

It was anticipated that the action on the guyed and unguyed poles, without hardware, crossarms, wire or cable, would produce results that would enable comparisons to be made between standard loading formulas and those loads introduced by atomic blast pressures.

The exposure boards were designed, oriented, and spaced so as to derive optimum thermal effects upon the test items at fixed distances from GZ.

The towers, antenna systems, masts and supports were designed and spaced so as to determine the various compression and drag loadings thereon. It was also desired to compare the peak overpressures with conventional wind velocities.

Field type radio sets and film badges were placed on the dummies in foxholes at graduated distances from GZ to determine the effects of the burst upon both the dummies and the equipment.

Of particular interest in connection with the AN/GRC-26 radio sets were the effects upon the shelters themselves and upon equipment in the shelters.

The Signal Supply Points were designed to test thermal and blast effects at varying distances from GZ.

Various items of equipment were placed in Ordnance Corps vehicles, Medical Corps, and Corps of Engineers installations to secure data on Signal items organic to tactical units. Utilization of these installations on a noninterference basis was considered to be economical from many points of view.

The cable manhole was added late in the planning stage. Although it was a field expedient, it produced results of value.

Area plot plans of the test layouts for Shots 9 and 10 are shown in Appendices A and B. These plans show the Test Group numbers, the geographic locations of the various test groups and their orientation

with respect to actual GZ. Distances shown in this report are from actual GZ.

In planning for these atomic weapons effects tests it was not contemplated that there would be any Project 3.20 participation in Shot 10. Upon arriving at the test site and in the process of further planning it was found that limited participation could be undertaken. If a test group from Shot 9 could not be completely rehabilitated or new equipment and material placed in position it was not subjected to test in Shot 10. The shortage of time for construction effort between tests, availability of funds, troop labor, non-availability of equipment and material were also limiting factors.

Qualified damage analysis personnel accompanied by photographers were dispatched to the test area after each test as soon as Rad-Safe permitted entry. The available data were secured and recorded on specially prepared damage analysis forms (see Fig. 2.3). These forms will remain in the files at the Coles Signal Laboratory for a reasonable period of time after which they will be destroyed. Subsequent to the preliminary report these data and laboratory test data have been evaluated and detailed results are contained in this report.

TEST GROUP NO.	66
TEST ITEM NO.	1
PHOTO NO.	D-754, F-162
P.S.I.	10.2
CAL. PER SQ C M	55

PROJECT 3.20

CHECK DISTANCE (FT) 500 [ ] 1000 [ ] 1500 [ ] 2000 [ ] 2600 [ ] 3000 [ ] 3500 [ ] 4000 [ ] 4500 [ ] 5000 [ ] 6000 [ ] 7000 [ ] 8000 [ ] 3150 [✓]

TEST ITEM DESCRIPTION W-110-B Field Wire

DAMAGE BY BLAST: BELOW SURFACE [ ] SURFACE [✓] ABOVE SURFACE [ ]

SEVERE

MODERATE

LIGHT

NO DAMAGE ✓

DAMAGE BY THERMAL: BELOW SURFACE [ ] SURFACE [✓] ABOVE SURFACE [ ]

SEVERE ✓

MODERATE

LIGHT

NO DAMAGE

CONDITION AFTER BLAST:

SERVICEABLE

NOT SERVICEABLE ✓

ESTIMATED REPAIR TIME

RADIATION

COMMENTS 3 Drums undamaged, blown away from GZ. 13 Drums destroyed, severly burned. Drums shielded from GZ by others were severly burned

NAME Joe Doe RANK Civilian DATE 5/12/53

Fig. 2.3 Sample Damage Analysis Form

CHAPTER 3

EXPERIMENT DESIGN, RESULTS, AND PHOTOGRAPHS

3.1 GENERAL

No suffix to a test group indicates that it was in Shot 9. The suffix A added to a test group indicates that it was in Shot 10.

The description of damage in this report is in accordance with definitions contained in TM 23-200, Capabilities of Atomic Weapons, paragraph 446, page 91 with one exception. For purposes of this report a category of "Negligible Damage" (N) has been added. The definitions of damage are reproduced below for purposes of ready reference.

(1) SEVERE DAMAGE (S) - That damage which is severe enough to prevent completely the accomplishment of any useful military function, and repair of which is essentially impossible without removal to a major repair facility.

(2) MODERATE DAMAGE (M) - That damage which is sufficient to prevent any military use until extensive repairs are effected.

(3) LIGHT DAMAGE (L) - That damage which will not seriously interfere with immediate military operation, but will necessitate some repair to restore items to complete military usefulness.

(4) (ADDED FOR THIS REPORT) NEGLIGIBLE DAMAGE (N) - That damage which will not require any repairs to be made.

3.2 RADIAL POLE LINES TEST GROUPS 1 AND 1A, SHOTS 9 AND 10

3.2.1 Radial Pole Line Test Group 1, Shot 9 (Figs. 3.1 thru 3.24)

a. DESIGN - A radial pole line began at a point 9080 ft North North East of GZ and extended in a straight line to a point 1250 ft North North East of GZ. This pole line contained 52 standard creosoted Southern Pine 30 ft class 7 poles with approximately 150 ft spacing set at a depth of 5½ ft. Digging conditions were excellent for the mechanical earth auger and the poles were well tamped. Poles D-14, D-28, and D-41 at 6950, 4750, and 2900 ft from GZ were four way storm guyed and termination poles at 9080 and 1250 ft and were dead ended with triple guys. All poles supported eight each No. 104 copper steel (CS) wires on 10 pin crossarms. The line was transposed for a C type carrier

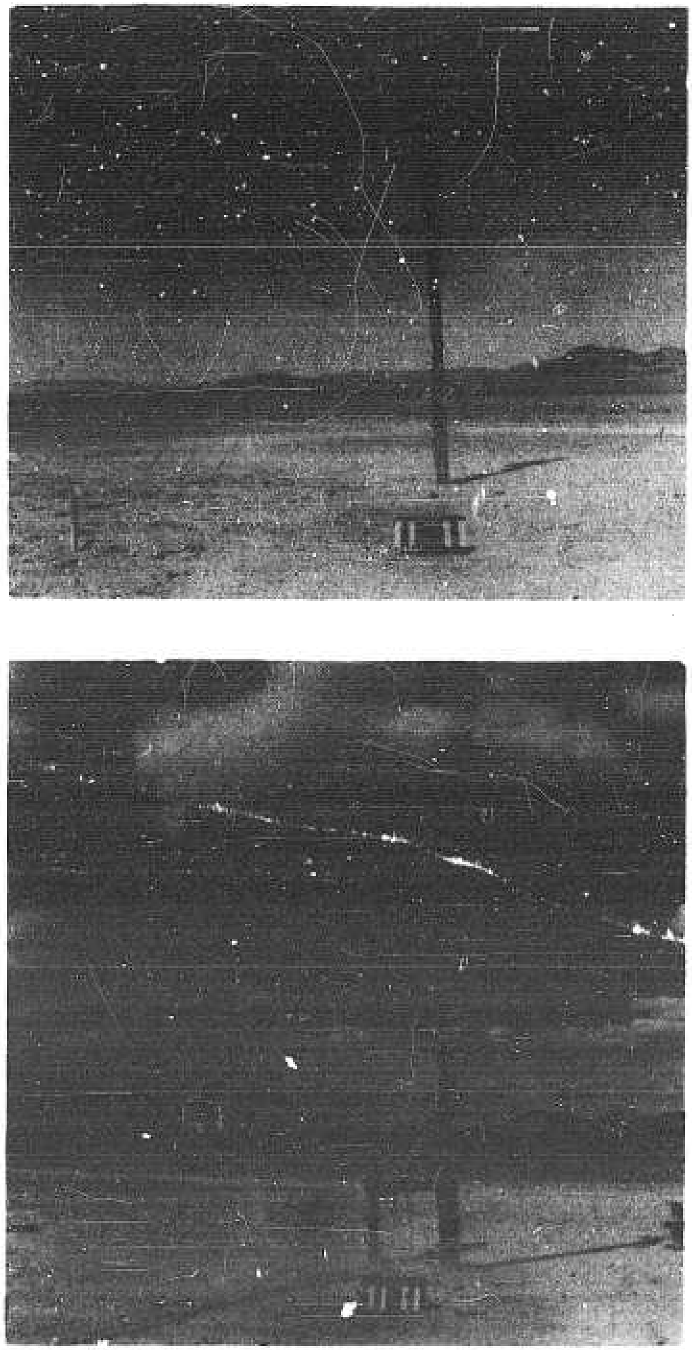
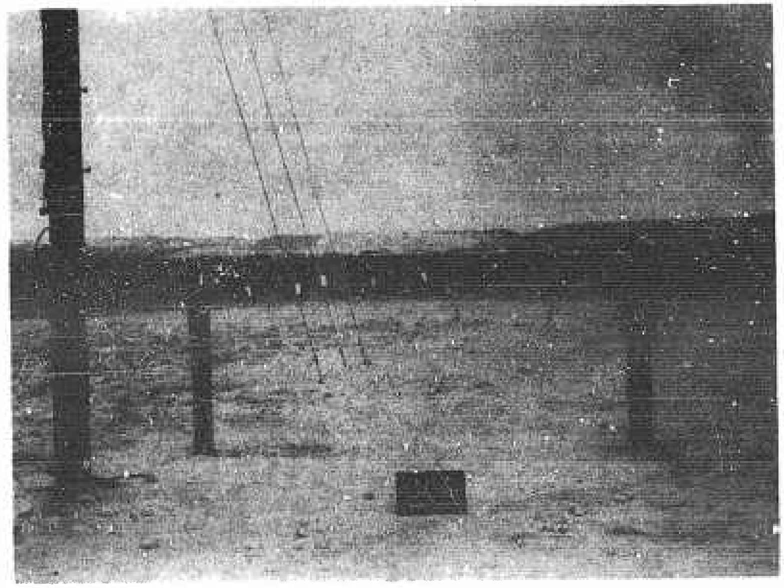


Fig. 3.1 Shot 9, Test Group 1, Radial Pole Line, Pole D-1 (Top-before, Bottom-after) (EE-8 Field Telephones in Bottom View were Installed Prior to Shot 9.) 9080 ft, 8 cal, 3 psi



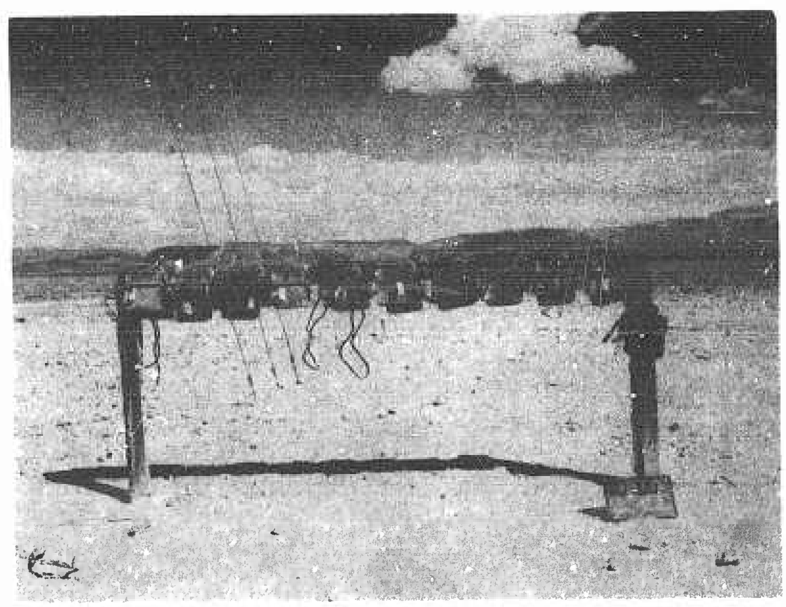


Fig. 3.2 Shot 9, Test Group 1, 1-1/2 Mile Pole Line, Pole D-1 and EE-8 Field Telephones used to Test Circuits. (Top-before, Bottom-after) 9080 ft, 8 cal, 3 psi

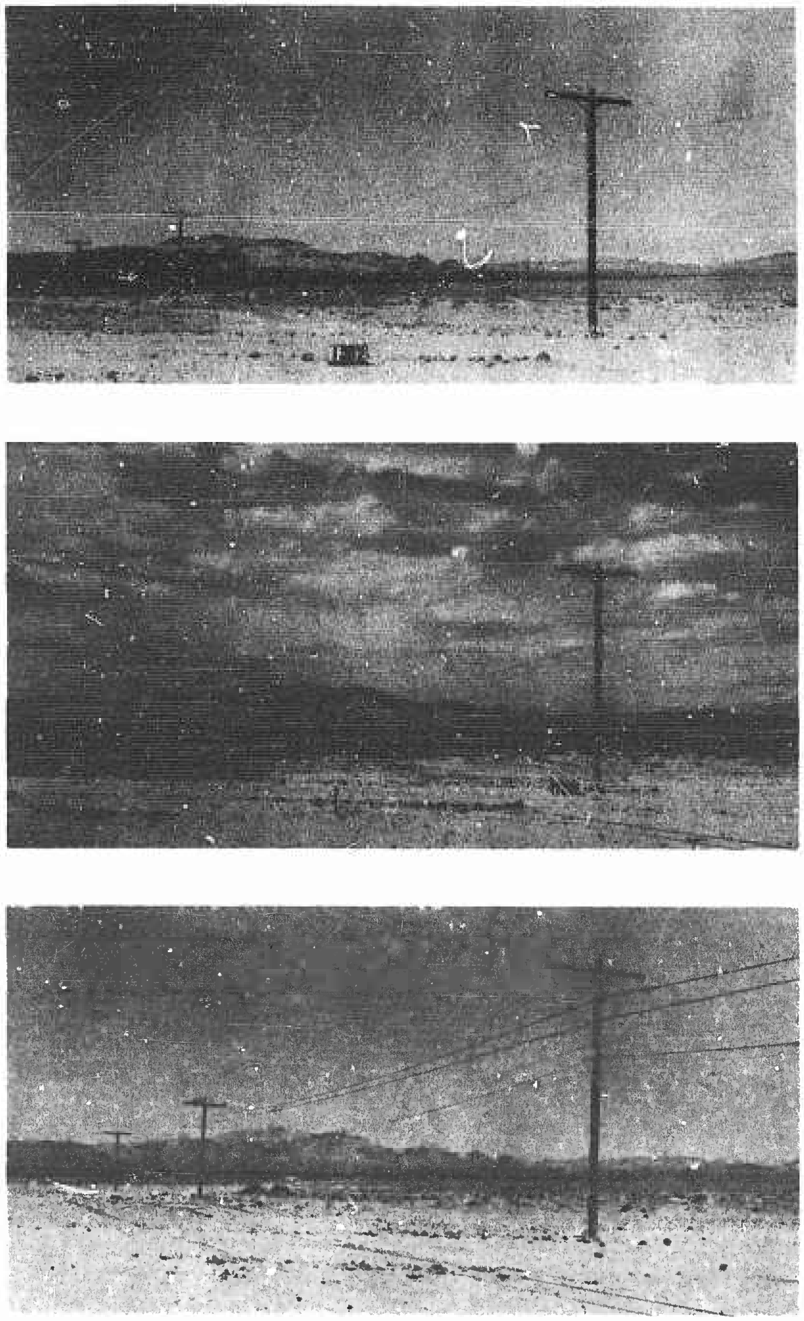


Fig. 3.3 Shots 9 and 10, Test Groups 1 and 1A, Radial Pole Line, Poles D-1 through D-4. D-4 in Foreground. (Top-before 9, Center-after 9, Bottom-after 10)
Shot 9 - 9080-8450 ft, 8-10 cal, 3-3.1 psi.
Shot 10 - 8350-7850 ft, 5.5-6.5 cal, 1-1 psi

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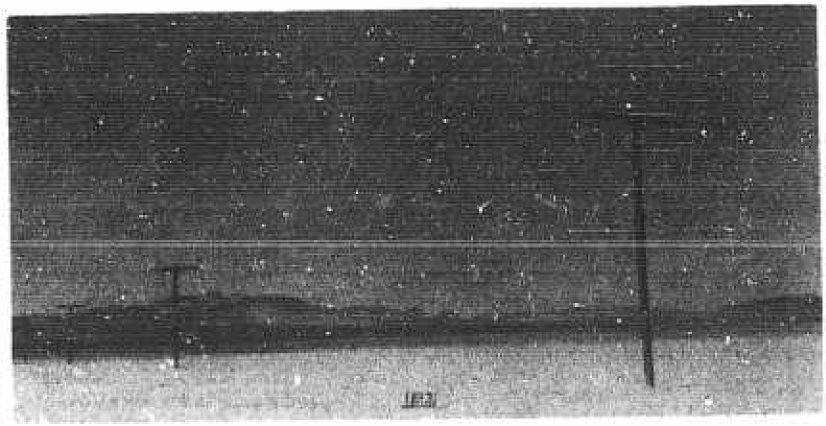
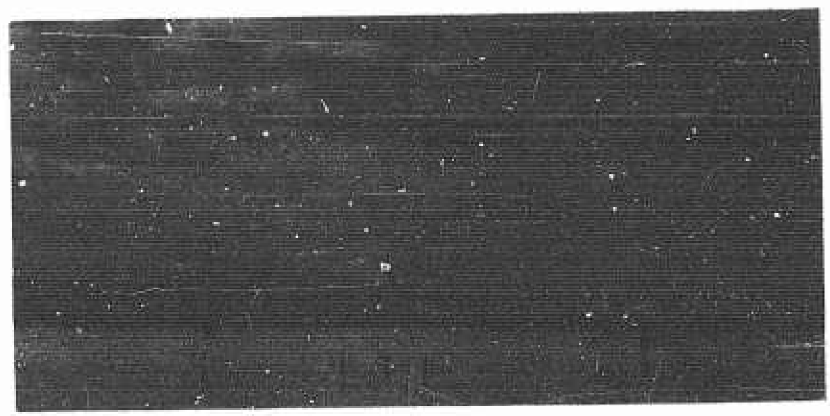




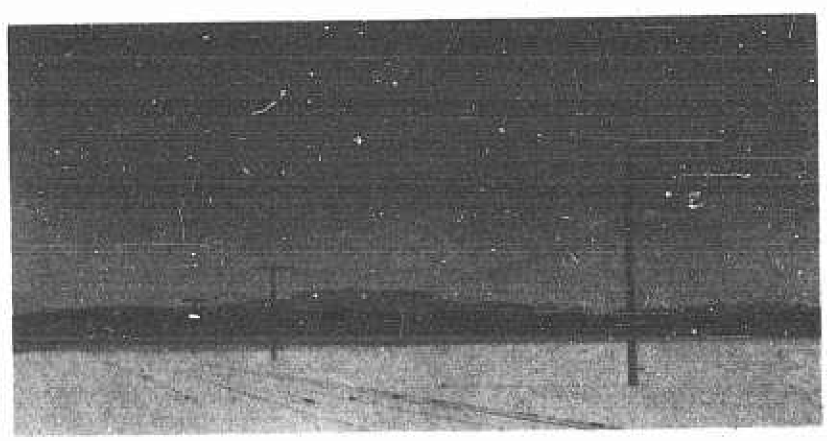


Fig. 3.4 Shots 9 and 10, Test Groups 1 and 1A, Radial Pole Line, Poles D-3 through D-7. D-7 in Foreground. (Top-before 9, Center-after 9, Bottom-after 10) Shot 9 - 8750-8050 ft, 9.5-11.5 cal, 3-3.4 psi. Shot 10 - 8000-7425 ft, 6-7.5 cal, 1-1 psi.

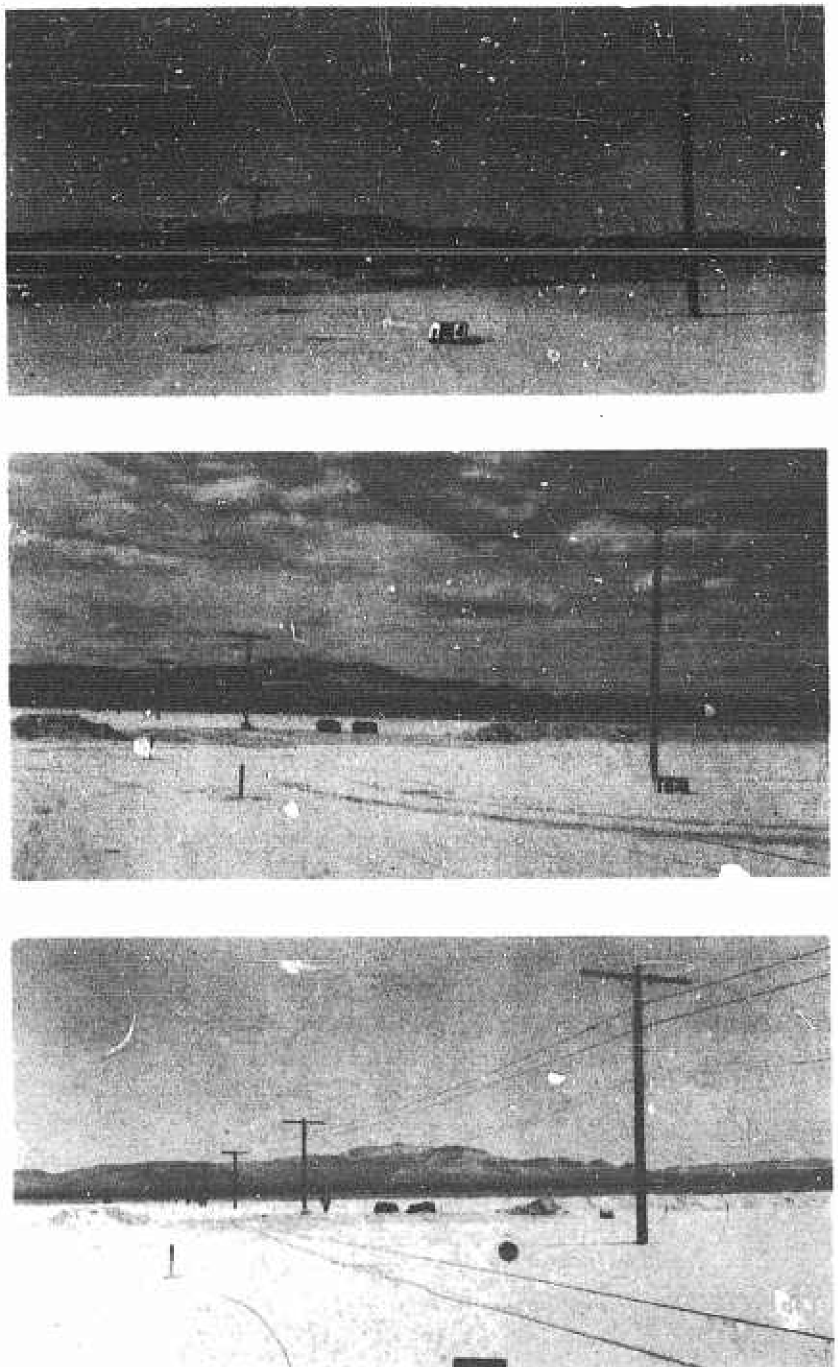


Fig. 3.5 Shots 9 and 10, Test Groups 1 and 1A, Radial Pole Line, Poles D-1 through D-10. D-10 in Foreground. (Top-before 9, Center-after 9, Bottom-after 10)
Shot 9 - 9080-7550 ft, 8-13 cal, 3-3.6 psi.
Shot 10 - 8350-6950 ft, 5.5-8.5 cal, 1-1 psi.

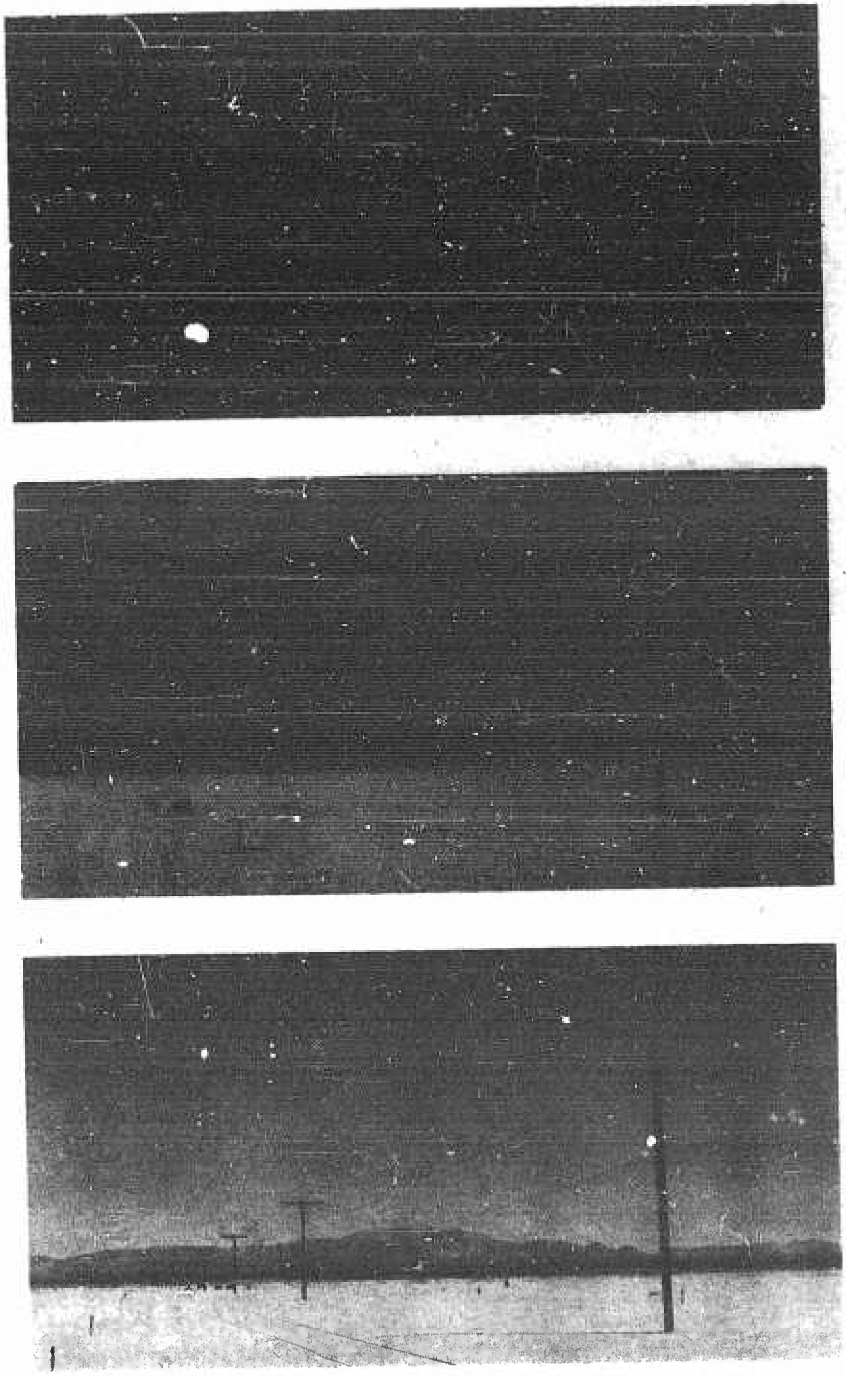


Fig. 3.6 Shots 9 and 10, Test Groups 1 and 1A, Radial Pole Line, Poles D-1 through D-13. D-13 in Foreground. (Top-before 9, Center-after 9, Bottom-after 10)
Shot 9 - 9080 ft, 8-15 cal, 3-4.1 psi.
Shot 10 - 8350-6480 ft, 5.5-10.5 cal, 1-2 psi.

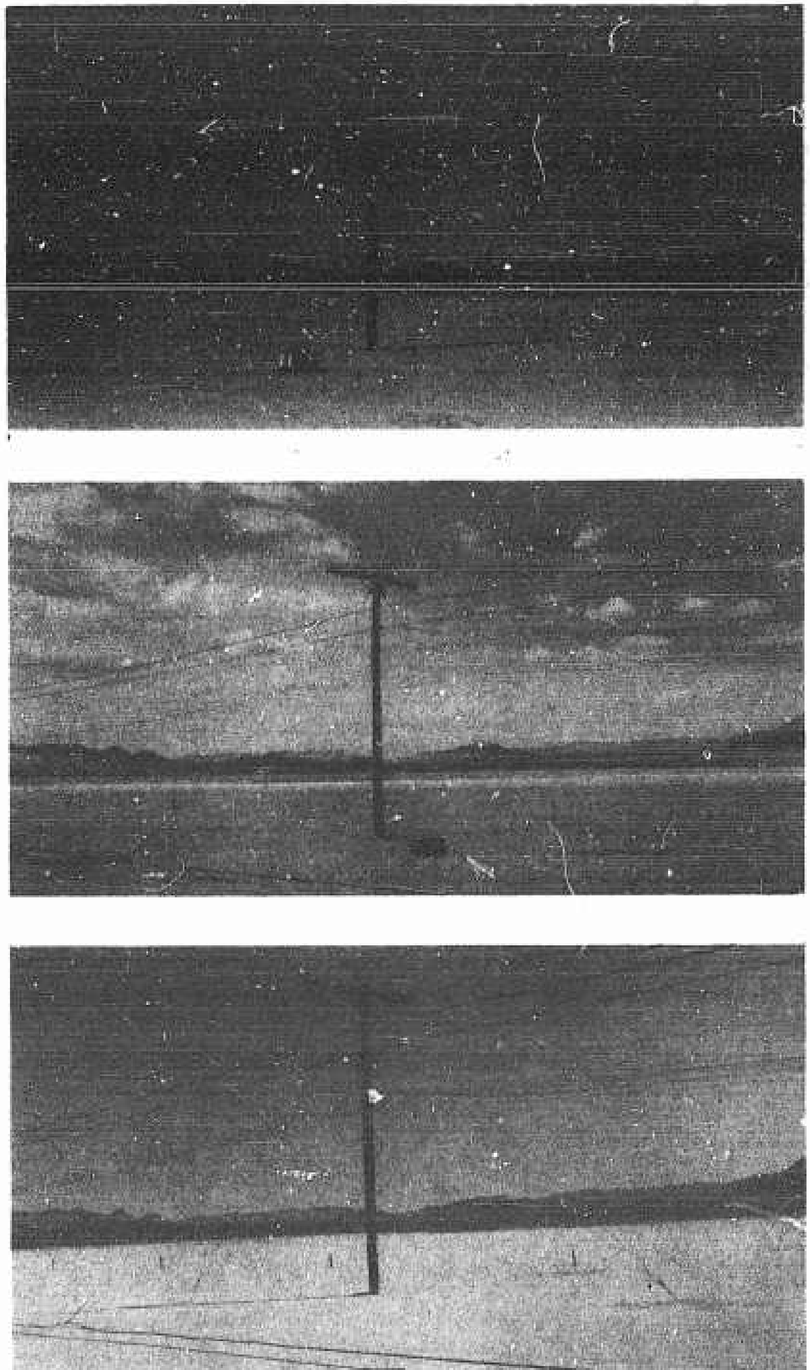


Fig. 3.7 Shots 9 and 10, Test Groups 1 and 1A, Radial Pole Line, Pole D-14. (Top-before 9, Center-after 9, Bottom-after 10)
Shot 9 - 6950 ft, 16 cal, 4.2 psi.
Shot 10 - 6350 ft, 10.5 cal, 2 psi.

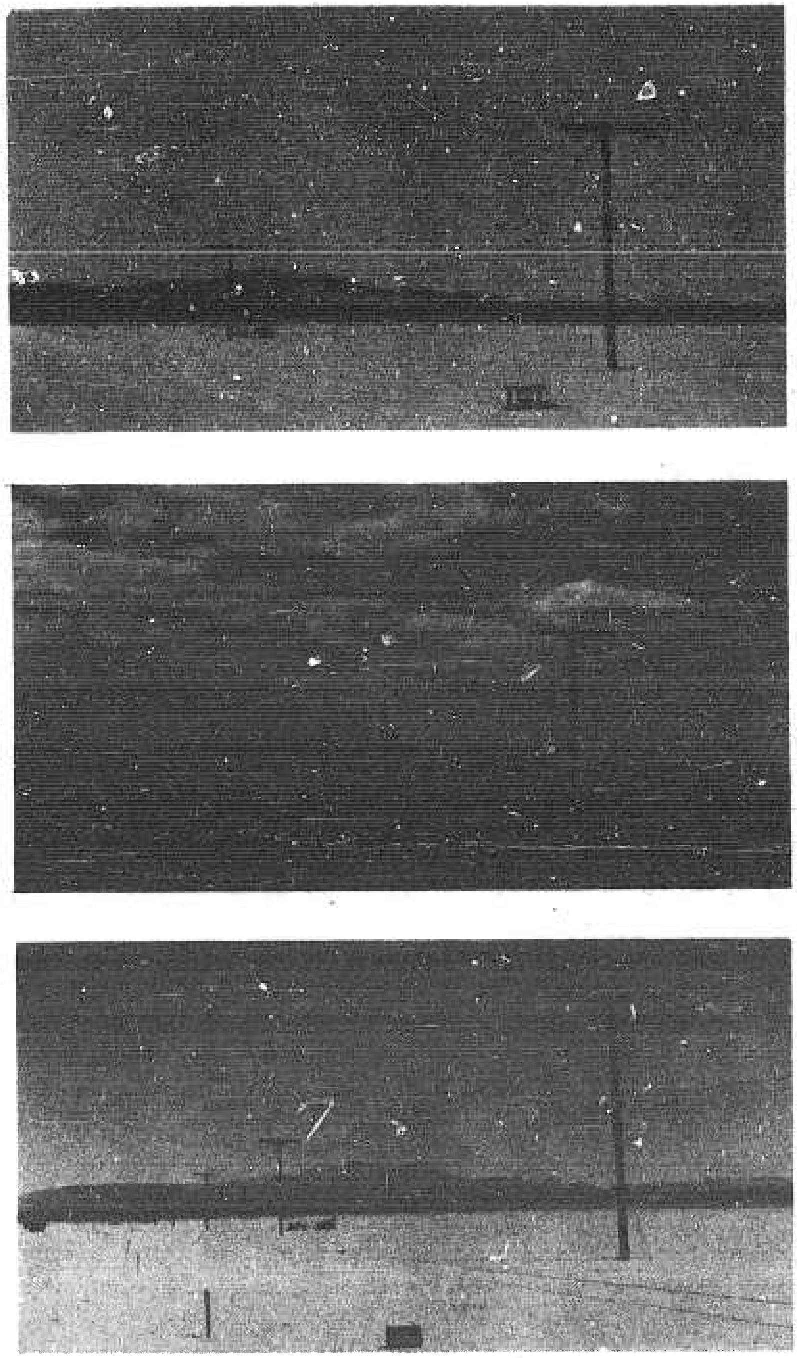


Fig. 3.8 Shots 9 and 10, Test Groups 1 and 1A, Radial Pole Line, Poles D-1 through D-17. D-17 in Foreground. (Top-before 9, Center-after 9, Bottom-after 10)
Shot 9 - 9080-6500 ft, 8-18.5 cal, 3-4.6 psi.
Shot 10 - 8350-5860 ft, 5.5-12.5 cal, 1-2 psi.

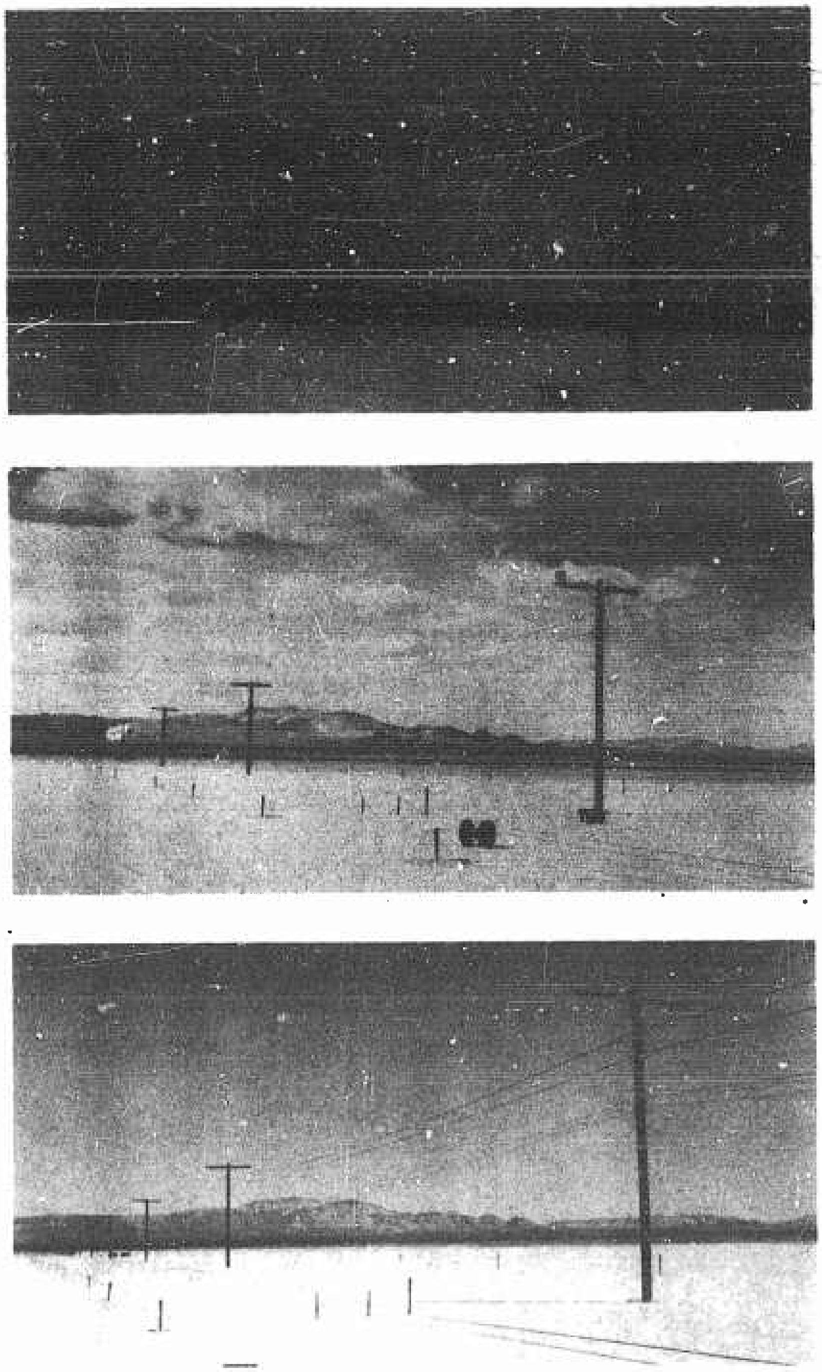


Fig. 3.9 Shots 9 and 10, Test Groups 1 and 1A, Radial Pole Line, Poles D-1 through D-20. D-20 in Foreground. (Top-before 9, Center-after 9, Bottom-after 10)
Shot 9 - 9080-6050 ft, 8-22 cal, 3-5 psi.
Shot 10 - 8350-5440 ft, 5.5-14.5 cal, 1-2 psi.

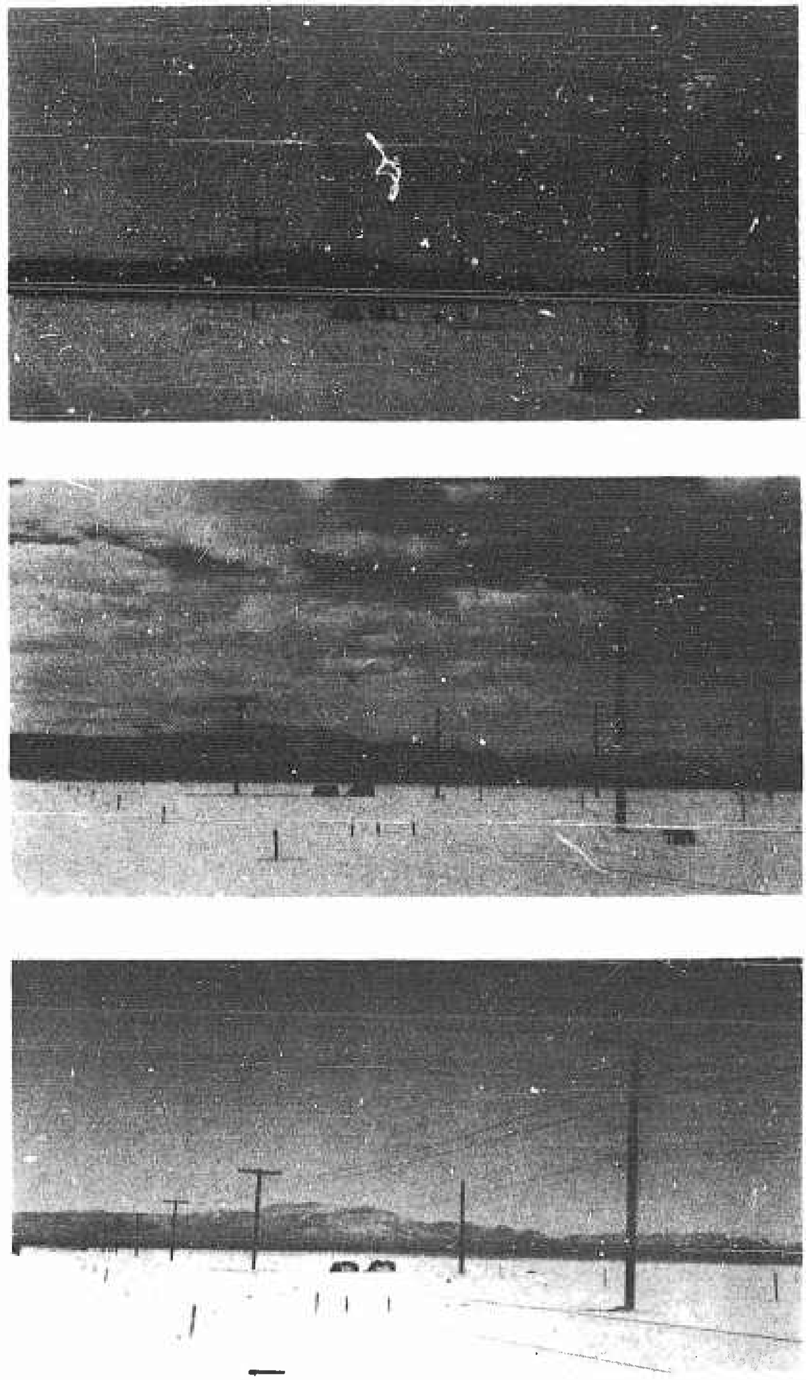


Fig. 3.10 Shots 9 and 10, Test Groups 1 and 1A, Radial Pole Line, Poles D-1 through D-23. D-23 in Foreground. (Top-before 9, Center-after 9, Bottom-after 10)
Shot 9 - 9080-5600 ft, 8-24.5 cal, 3-5.4 psi.
Shot 10 - 8350-4975 ft, 5.5-17.5 cal, 1-3.5 psi.

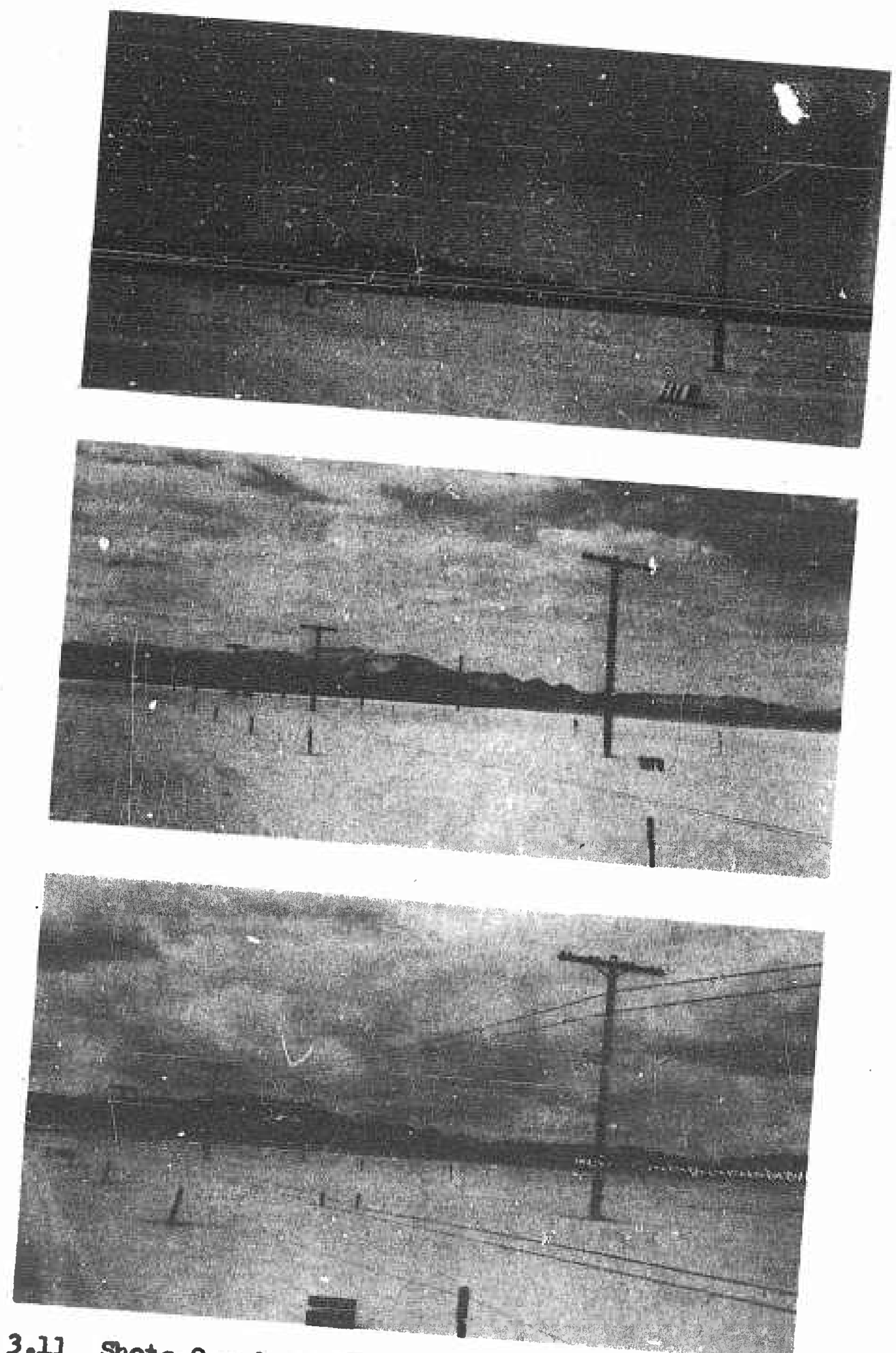


Fig. 3.11 Shots 9 and 10, Test Groups 1 and 1A, Radial Pole Line, Poles D-1 through D-26. D-26 in Foreground. (Top-before 9, Center-after 9, Bottom-after 10) Shot 9 - 9080-5150 ft, 8-27.5 cal, 3-5.8 psi. Shot 10 - 8350-4500 ft, 5.5-21 cal, 1-4 psi.

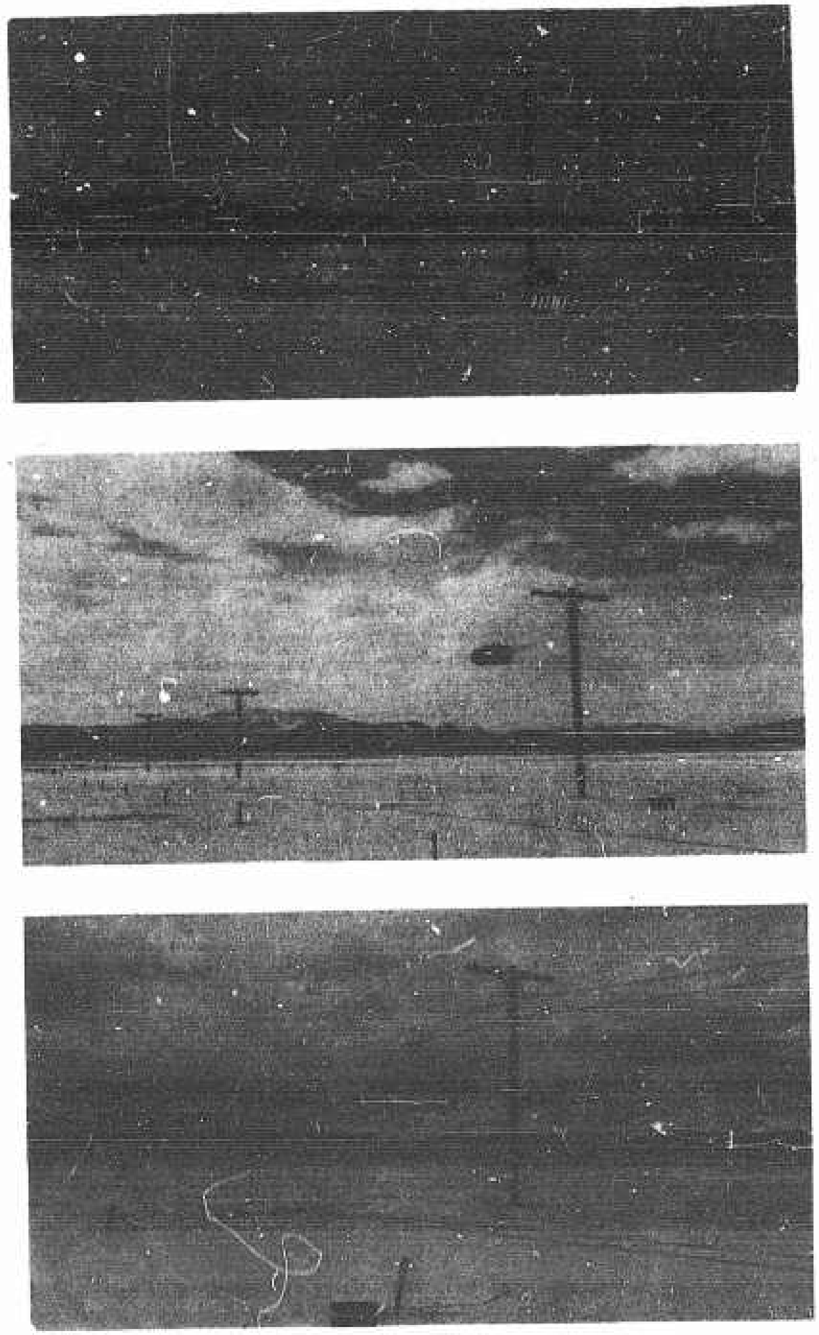


Fig. 3.12 Shots 9 and 10, Test Groups 1 and 1A, Radial Pole Line, Poles D-25 through D-28. D-28 in Foreground. (Top-before 9, Center-after 9, Bottom-after 10)
Shot 9 - 5280-4750 ft, 26.5-31 cal, 5.7-6.6 psi.
Shot 10 - 4670-4150 ft, 20.5-24.5 cal, 4-4 psi.

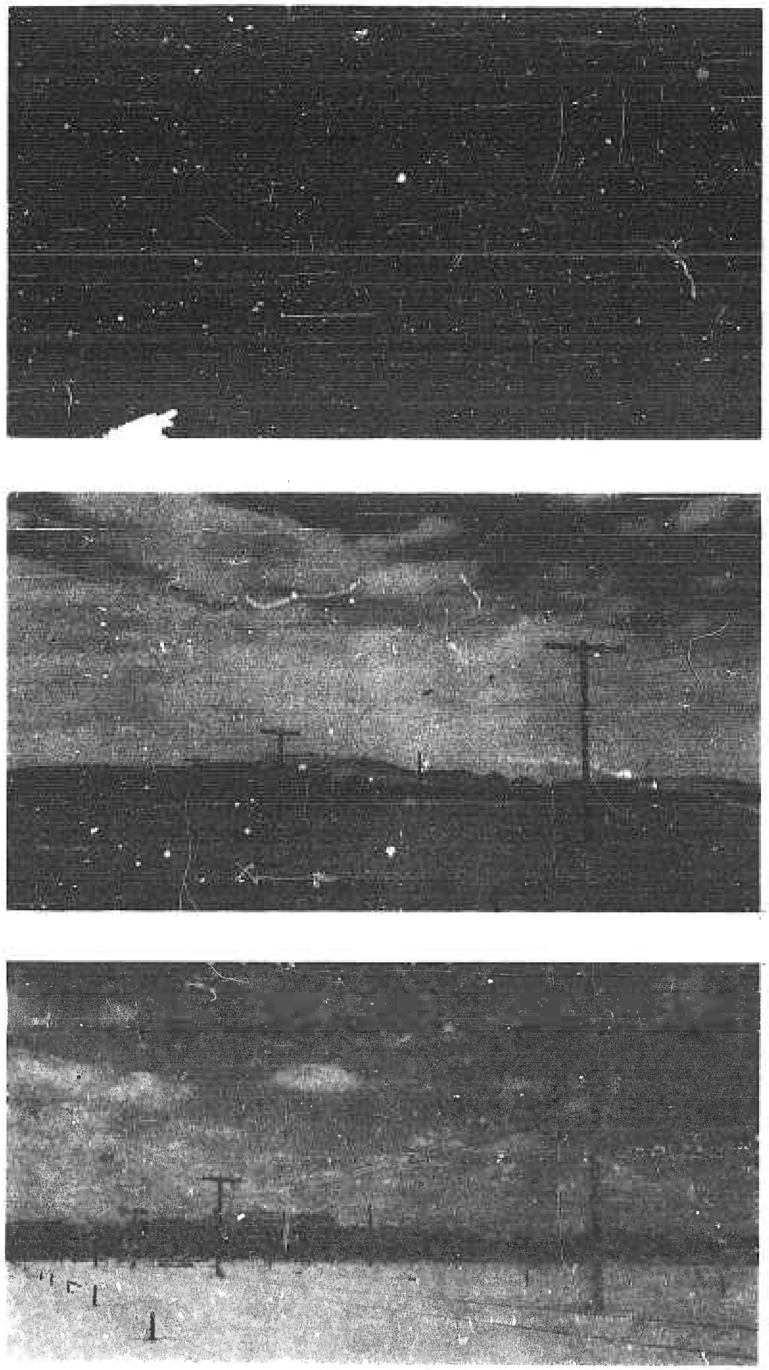


Fig. 3.13 Shots 9 and 10, Test Groups 1 and 1A, Radial Pole Line, Poles D-1 through D-31. D-31 in Foreground. (Top-before 9, Center-after 9, Bottom-after 10)
Shot 9 - 9080-4380 ft, 8-35 cal, 3-7.2 psi.
Shot 10 - 8350-3750 ft, 5.5-27 cal, 1-4 psi.

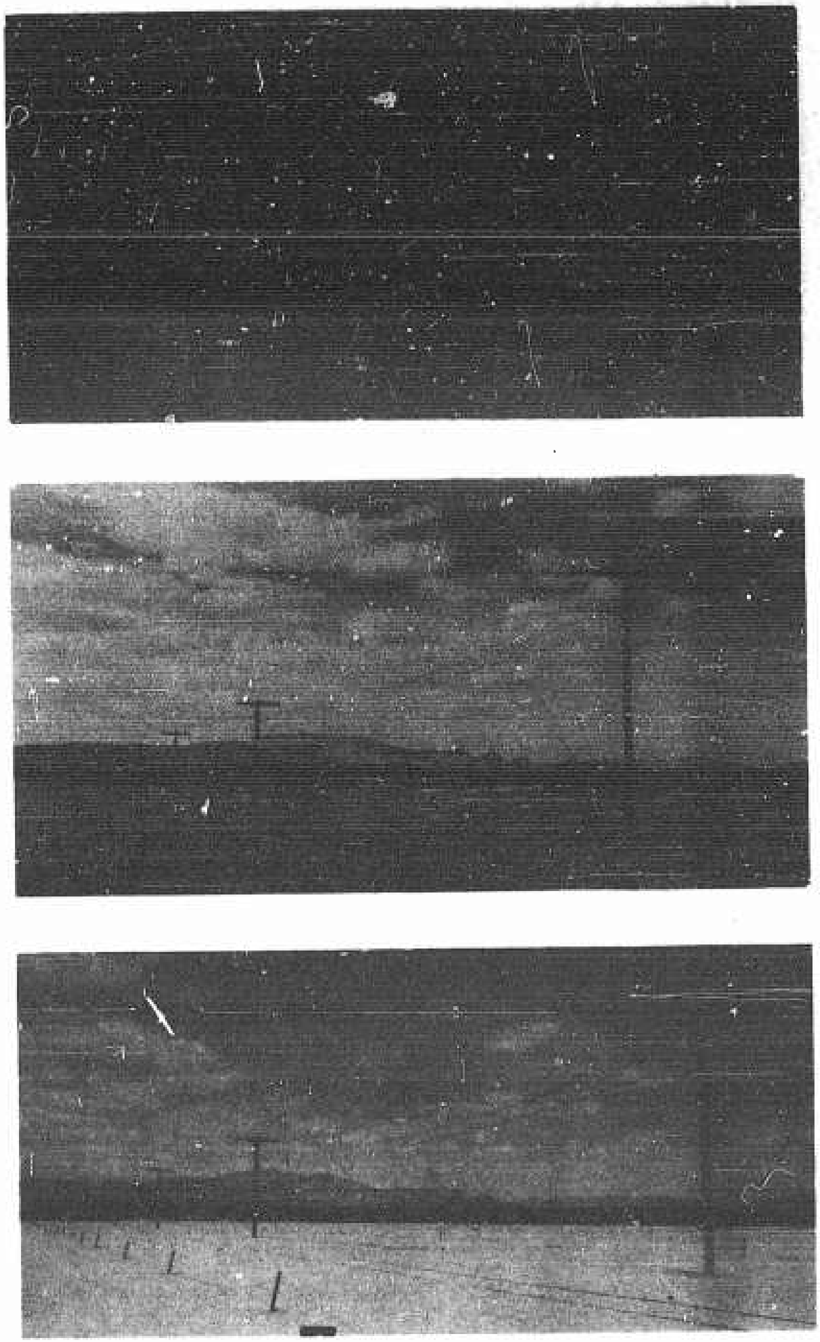


Fig. 3.14 Shots 9 and 10, Test Groups 1 and 1A, Radial Pole Line, Poles D-1 through D-34. D-34 in Foreground. (Top-before 9, Center-after 9, Bottom-after 10) Shot 9 - 9080-3900 ft, 8-42.5 cal, 3-8.4 psi. Shot 10 - 8350-3300 ft, 5.5-37.5 cal, 1-5 psi.

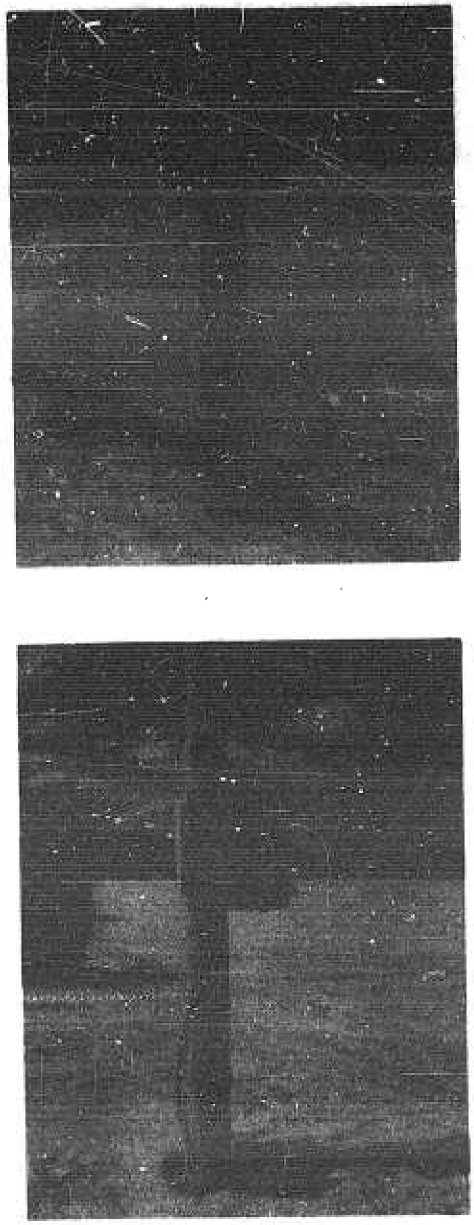


Fig. 3.15 Shot 9, Test Group 1, Radial Pole Line, Cable Transfer Relay on Pole D-35. (Top-before, Bottom-after) 3750 ft, 44.5 cal, 8.8 psi.

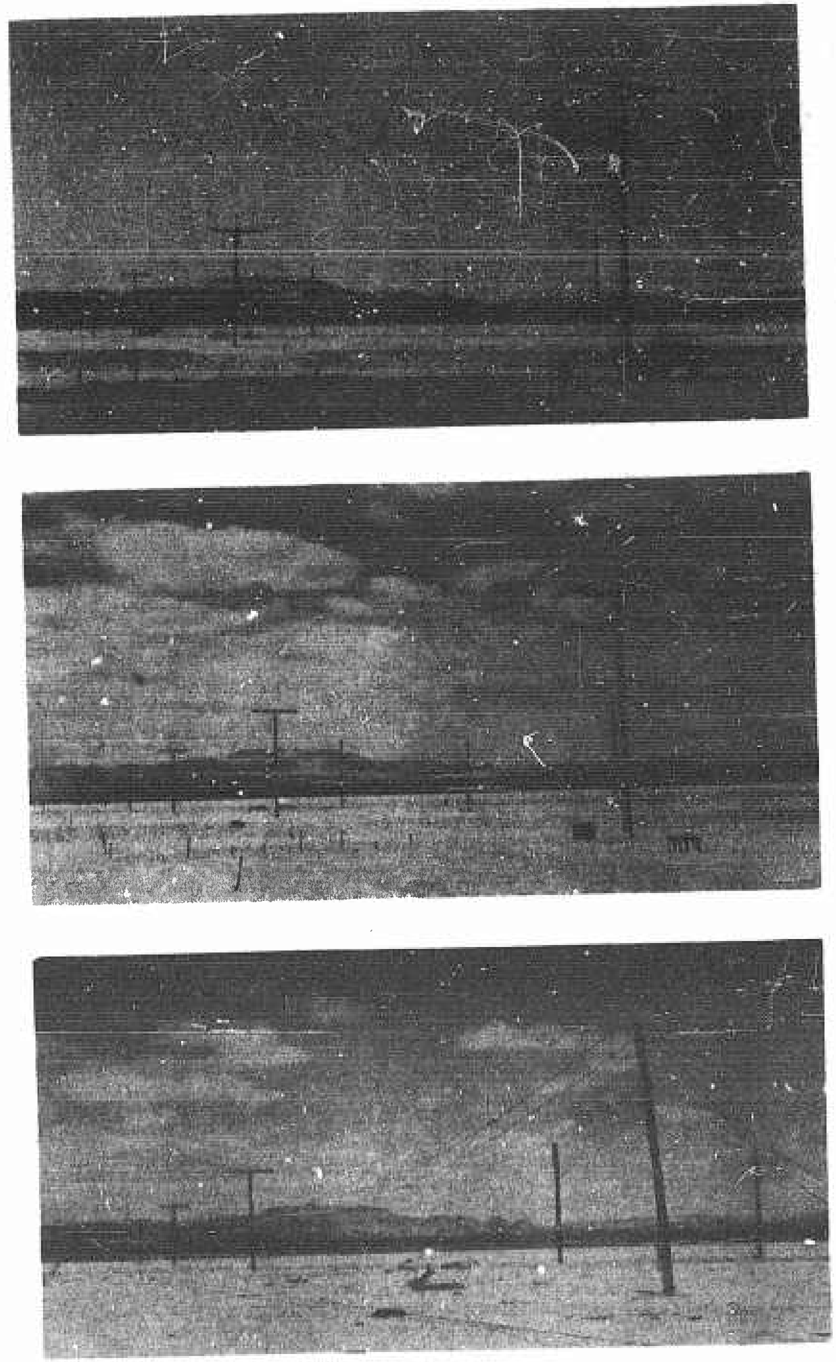


Fig. 3.16 Shots 9 and 10, Test Groups 1 and 1A, Radial Pole Line (Top-before 9, Poles D-1 through D-37; Center-after 9, Poles D-1 through 37; Bottom-after 10, Poles D-1 through D-36) (D-37 through D-52 Not Shown in this Photo were Destroyed in Shot 10) Shot 9 - 9080-3500 ft, 8-49 cal, 3-9.4 psi. Shot 10 - 8350-2900 ft, 5.5-47.5 cal, 1-5 psi.

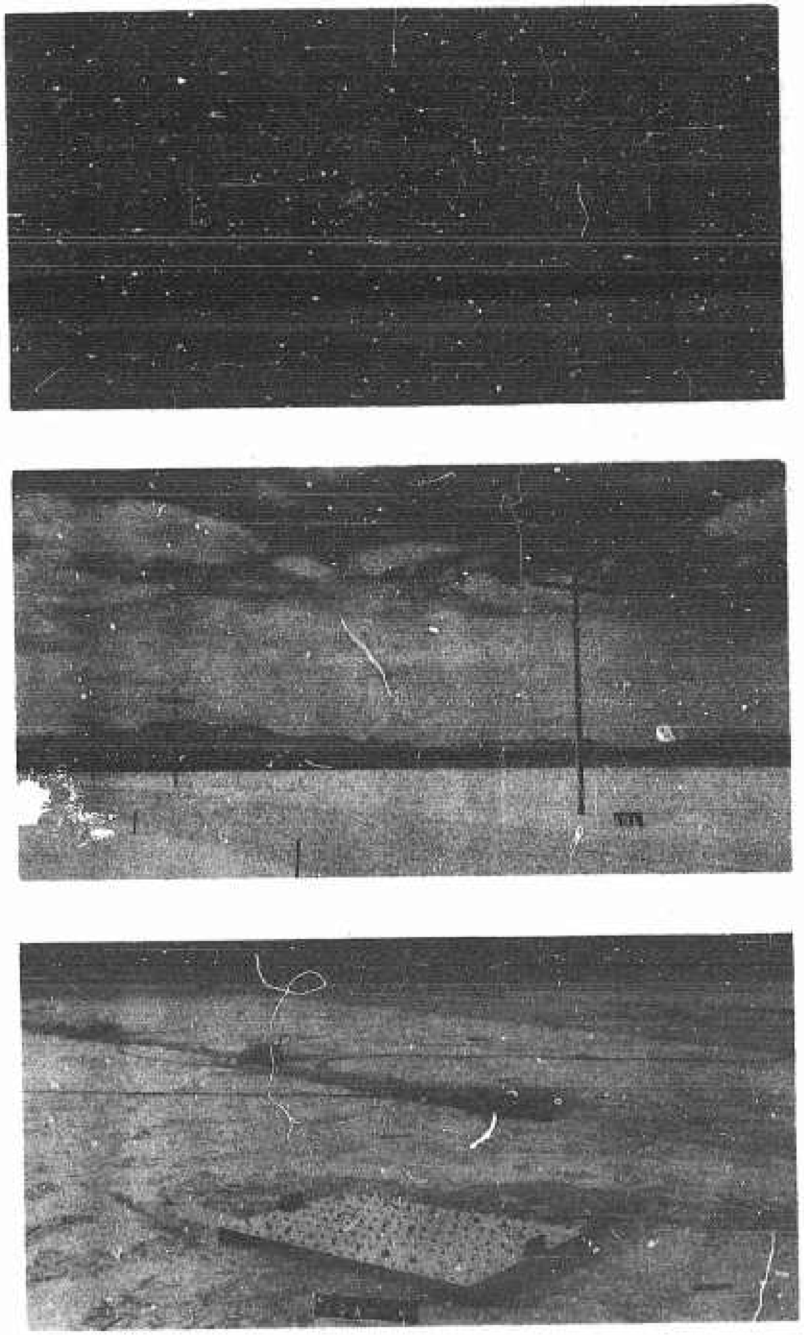


Fig. 3.17 Shots 9 and 10, Test Groups 1 and 1A, Radial Pole Line, Poles D-1 through 40, Top and Center Views. D-40 in Foreground; D-1 through D-40 in Bottom View, D-36 in Background. Poles D-37 through D-52 were Destroyed in Shot 10. (Top-before 9, Center-after 9, Bottom-after 10) Shot 9 - 9080-3050 ft, 8-57.5 cal, 3-10.4 psi. Shot 10 - 8350-2425 ft, 8- over 65 cal, 1-6 psi.

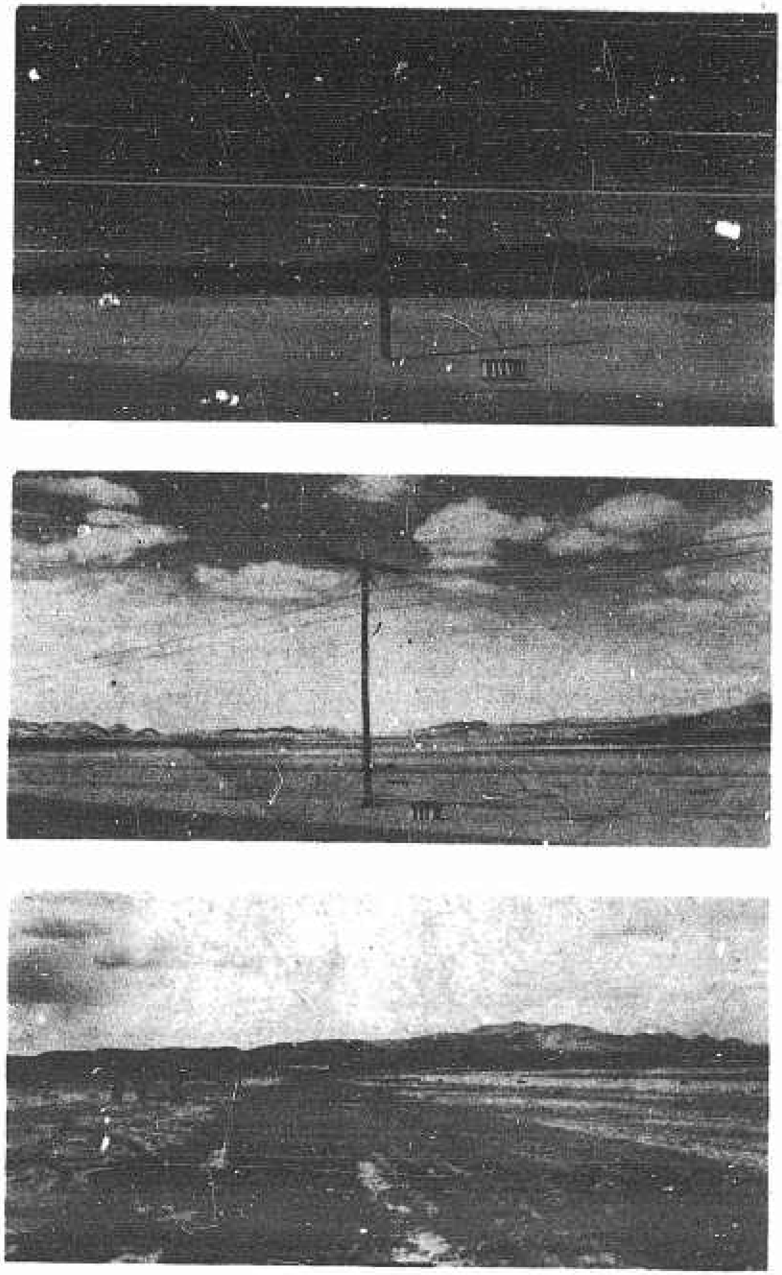


Fig. 3.18 Shots 9 and 10, Test Groups 1 and 1A, Radial Pole Line, Pole D-41. In Bottom View Poles D-37 through D-52 Destroyed in Shot 10. (Top-before 9, Center-after 9, Bottom-after 10)
Shot 9 - 2900 ft, 60 cal, 10.6 psi.
Shot 10 - 2250 ft, 65 cal, 7 psi.

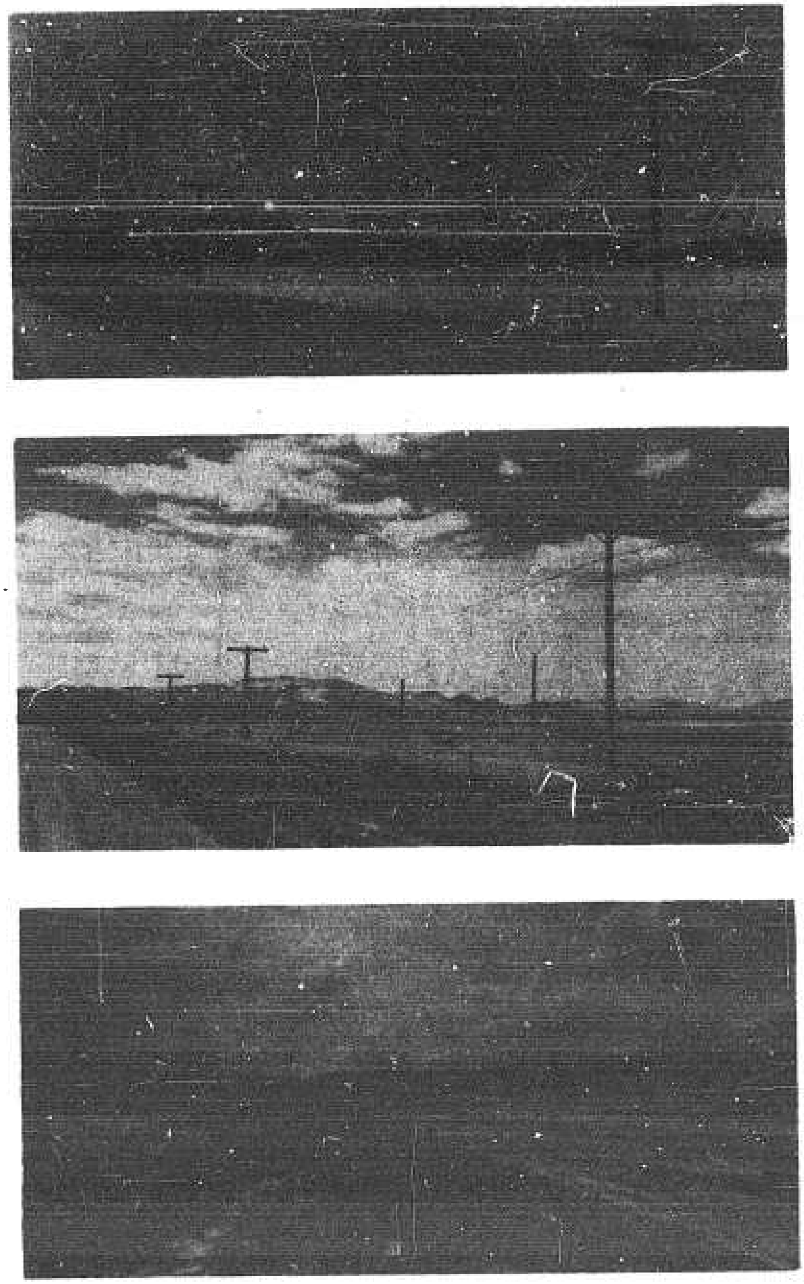


Fig. 3.19 Shots 9 and 10, Test Groups 1 and 1A, Radial Pole Line, Poles D-1 through D-44. D-44 in Foreground in Top and Center Views. In Bottom View Poles D-37 through D-52 have been destroyed in Shot 10. (Top-before 9, Center-after 9, Bottom-after 10)
Shot 9 - 9080-2450 ft, 8-69 cal, 3-11.2 psi.
Shot 10 - 8350-1820 ft, 5- over 65 cal, 1-9 psi.

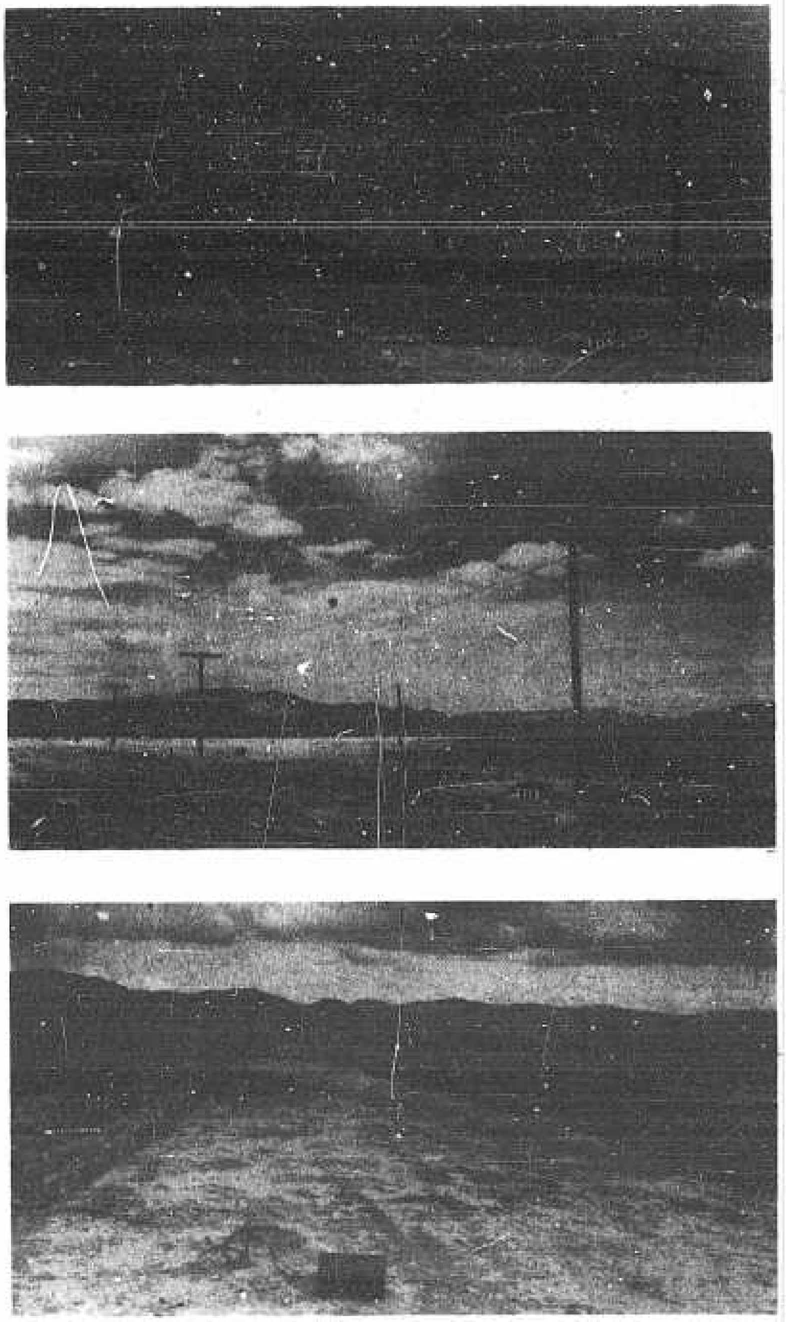


Fig. 3.20 Shots 9 and 10, Test Groups 1 and 1A, Radial Pole Line, Poles D-1 through D-47. D-47 in Foreground in Top and Center Views. In Bottom View Poles D-37 through D-52 have been Destroyed, D-41 Position in Foreground. (Top-before 9, Center-after 9, Bottom-after 10) Shot 9 - 9080-2000 ft, 8-82 cal, 3-12.6 psi. Shot 10 - 8350-1350 ft, 5.5-over 65 cal, 1-20 psi.

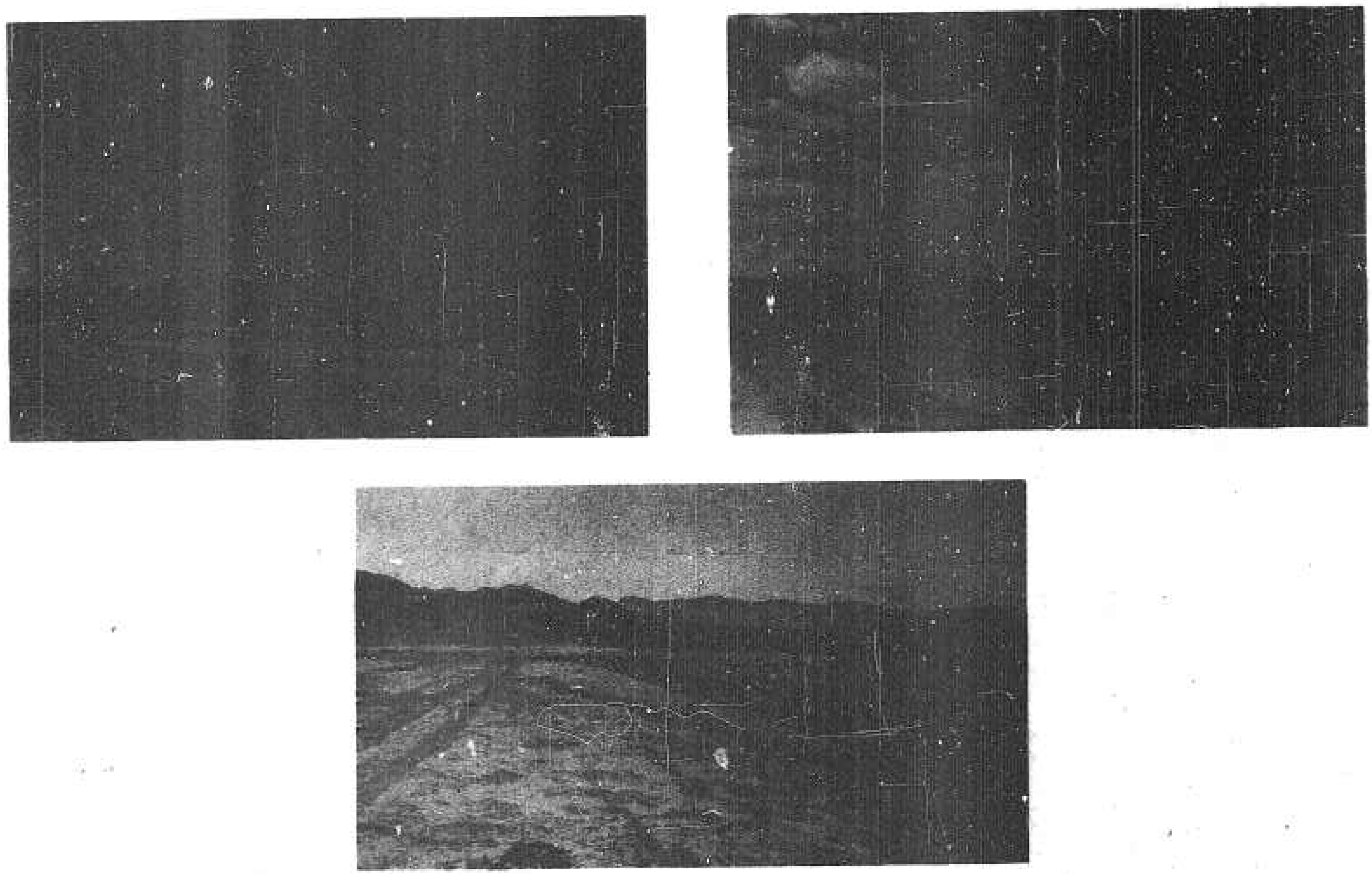


Fig. 3.21 Shots 9 and 10, Test Groups 1 and 1A, Radial Pole Line, Poles D-1 through D-50. D-50 in Foreground in Top left and Top right Views. In Bottom View Poles D-37 through D-52 have been Destroyed, D-41 Position in Foreground. (Top-before 9 (left), after 9 (right), Bottom-after 10) Shot 9 - 9080-1550 ft, 8-98 cal, 3-14.6 psi. Shot 10 - 8350-900 ft, 5.5-over 65 cal, 1-65 psi.

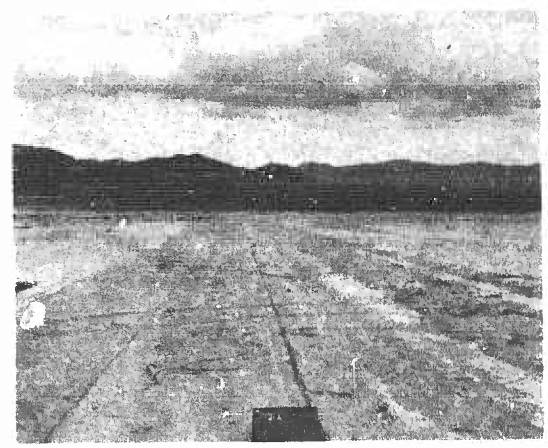


Fig. 3.22 Shots 9 and 10, Test Groups 1 and 1A, Radial Pole Line, Poles D-52 through D-50 in Top View, D-52 in Foreground; Poles D-52 through D-1 in Bottom Left View, D-52 in Foreground; Poles D-52 through D-36 Bottom Right View Destroyed in Shot 10. (Top-before 9, Bottom Left-after 9, Bottom Right-after 10)
Shot 9 - 1550-1250 ft, 98-113 cal, 14.16.6 psi.
Shot 10 - 2250-600 ft, over 65 cal, 7.0-over 115 psi.

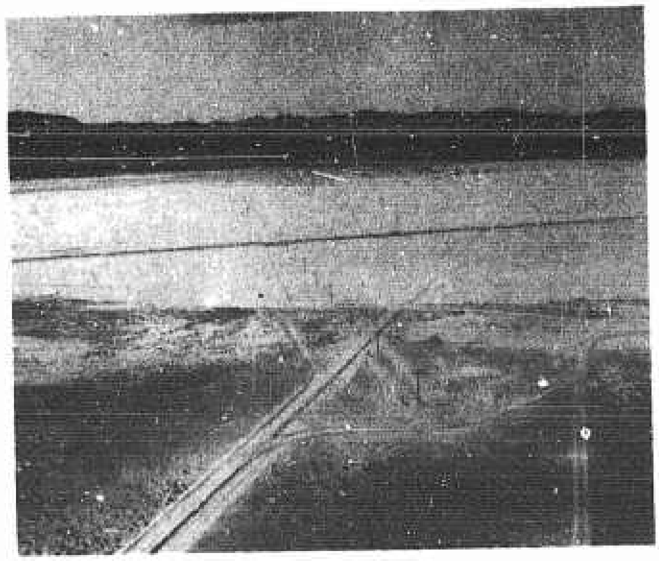
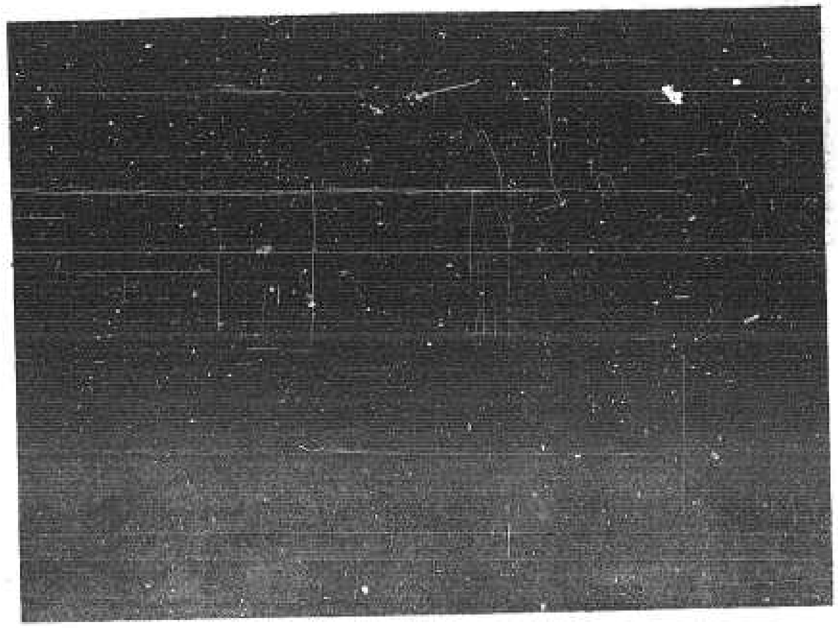


Fig. 3.23 Shot 10, Miscellaneous Aerial Views, Test Group 1A, Radial Pole Line. All Views after Shot 10. (Top-entire Pole Line from Poles D-1 through D-52, D-1 in Foreground; Bottom-poles D-27 through D-37; Note All Poles Down, D-36 through D-52.



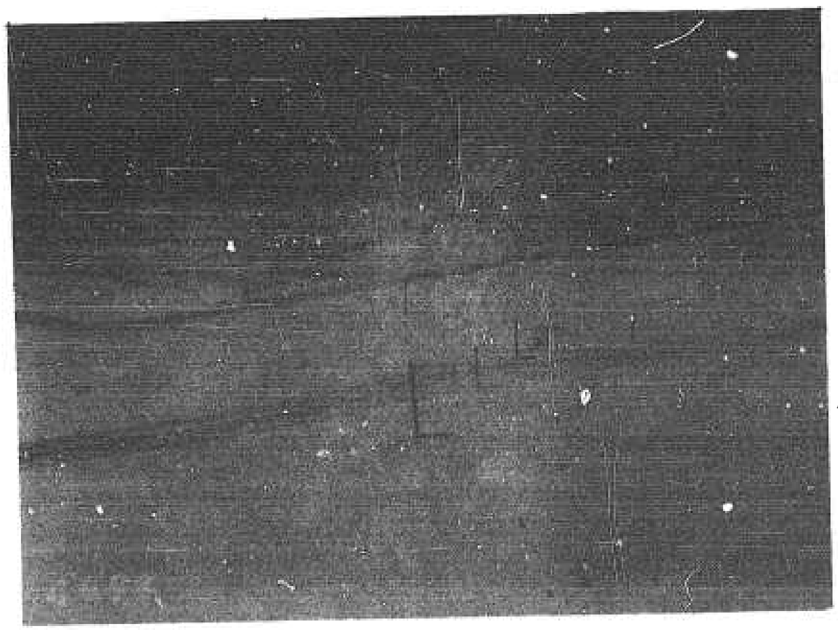


Fig. 3.24 Shot 10, Miscellaneous Aerial Views Test Group 1A, Radial Pole Line. All Views after Shot 10. (Top-from Left to Right Poles D-39 through D-21. Note that Poles D-39 through D-37 are Broken and on the Ground. Also Note that Test Group 6A, 3 Separate Poles (Top Left) are Broken whereas in Test Group 7A (To the Right of Pole D-35) Remained Standing and Received Negligible Damage. Bottom-close up of Poles D-39 through D-35 and Test Group 7A)

using standard drop brackets. In addition to the open wire, the poles supported one 26 pair, lead-covered cable lashed to a W-115 messenger with 0.045 in.diameter stainless steel lashing wire; one 5 pair, rubber cable (CX-162/G) lashed to a W-115 messenger with 0.045 in. diameter lashing wire; 1 spiral four cable (CX-1065/G) self supporting; and from 1 to 11 WD-1/TT field wires. (Only one pair of field wires ran the full length of the pole line. The other pairs were looped back to a terminal strip at pole D-1 from points at 5730, 3750, 2750, and 1850 ft from GZ.) Commercial type cable transfer relays were mounted 5 ft above the ground on the GZ side of poles D-42 (2750 ft) and D-52 (1250 ft) from GZ.

b. RESULTS - The pole line as a whole, except for the WD-1/TT field wire looped circuits, received only light damage. Details of the damage are covered in the following breakdown.

(1) POLES: Thermal damage to the poles negligible, consisting only of light surface charring of the GZ faces of the poles. Detailed damage criteria are shown in Table 3.1

(2) CROSSARMS: All crossarms received slight surface charring on the GZ faces but damage was negligible. The outside crossarm of double crossarm on the dead end pole closest to GZ (pole D-52 at 1250 ft; 113 cal, 16.6 psi) was slightly twisted. All crossarms were serviceable after the shot.

(3) INSULATOR PINS: None of the wooden insulator pins received any apparent damage.

(4) GLASS INSULATORS: All insulators on the outside crossarms on the dead end pole (pole D-52 at 1250 ft; 113 cal, 16.6 psi) were broken. There were two broken insulators on pole D-51 at 1400 ft; 103 cal, 15.4 psi. In all cases where there were broken insulators the open wire remained attached to the insulator and pin. All other insulators were serviceable after the shot.

(5) GUYS AND ANCHORS: None of the guys or anchors received any apparent damage. The tension on the guys was not appreciably altered.

(6) OPEN WIRE: There was no apparent damage to the 104 CS open wire. A piece of burned WD-1/TT wire and a piece of barbed wire from a nearby land mine fence were blown across and short circuited the open wire circuits. All open wire circuits were operable after the short circuiting wires were removed.

(7) 26 PAIR LEAD COVERED CABLE: The only damage to the 26 pair lead covered cable occurred at the last six poles closest to GZ (poles D-52 through D-47; 1250-2000 ft, 113-82 cal, 16.6-12.6 psi). In this section the lead sheath ruptured and separated adjacent to the messenger suspension clamp exposing the paper covered conductors all the way around the cable for a distance of 1/2 to 1 in. Twenty-five of the 26 pairs in the cable were operable after the shot. Wet weather would render this damaged cable inoperative should immediate repairs not be made.

(8) FIVE PAIR RUBBER COVERED CABLE CX-162/G: The rubber surface of this cable showed a slight blackening and roughening due to thermal energy from 1250 ft to 2750 ft, 113-62 cal. This thermal damage was superficial and may be considered negligible. The cable lashing wire was broken in two places between poles D-47 and D-45,

2000-2300 ft, 82-73 cal, 12.6-11.6 psi, allowing the cable to sag below the messenger.

(9) SPIRAL FOUR CABLE CX-1065/G: This cable showed a blackening and roughening of the rubber jacket. A summary of the damage is shown in the Table 3.2.

TABLE 3.1 - Damage Summary

Poles - Radial Pole Line - Test Group 1 (Shot 9)

Pole Numbers	Ft from GZ	cal	psi	Thermal Damage	Blast Damage	Remarks
D-52	1250	113	16.6	N	N	Surface of pole facing GZ showed light charring. Several cracks up to 4 in. in depth in lower half pole
D-51	1400	103	15.4			
D-22	5730	24	5.2	N	N	Surface of poles facing GZ slightly charred.
D-21	5950	22.5	5.0	N	N	Surface of pole facing GZ slightly charred. 3/4 in. to 1 in. cracks 3 in. deep from base up to 10 ft height along west side of pole.
D-20 thru D-2	6050 8900	22 9	5.0 3.0	N	N	Slight charring of pole D-20, slight scorching of wood and GZ face of pole D14. Slight blackening of pole D-20 attributed to creosote being drawn out of GZ side of pole by heat.
D-1	9080	8.0	3.0	N	N	Slight blackening of pole.

NOTE: All poles considered to be serviceable after Shot 9.
All poles were slightly loosened at the surface and required retamping.
No damage can be attributed to movement of the poles.

TABLE 3.2 - Damage Summary

Spiral Four Cable - Radial Pole Line - Test Group 1 (Shot 9)

Pole Numbers	Ft from GZ	cal	psi	Thermal Damage	Blast Damage	Remarks
D-52	1250	113	16.6	L	N	Rubber jacket roughened and blackened. 3 ft slack in last span caused by softening of jacket permitting slippage of woven wire suspension bracket several inches.
D-51	1400	103	16.6	L	N	Rubber jacket roughened and blackened.
D-50 to D-43	1550 2600	98 67	14.6 10.8	L	N	Rubber jacket roughened and blackened. (Woven wire suspension bracket failed at pole D-50).
D-42	2750	63	10.8	L	N	Rubber jacket roughened and blackened.
D-41 to D-38	2900 3350	60 52	10.6 9.8	L	N	As above.
D-37	3500	49	9.4	L	N	As above.
D-27 to D-1	4950 9080	29 8.0	6.2 3.0	N	N	As above.

(10) FIELD WIRE WD-1/TT: This wire received greater damage, primarily thermal damage, than any of the wire and cable. A summary of the damage is shown in Table 3.3.

(11) CABLE TRANSFER RELAYS: The cable transfer relays mounted on poles D-52 (1250 ft, 113 cal, 16.6 psi) and D-42 (2750 ft, 63 cal, 10.8 psi) showed no visible damage other than that the lead sheath on the riser cables was melted away for lengths of several inches on the GZ side exposing the paper covered conductors. Laboratory analysis of these relays reveals that these two relays were sound structurally and undamaged mechanically. There was no evidence of thermal damage to the relays, housing, mounting details or damage to the internal wires or insulation. These units were found to be in an immediate reusable state. Service would not have been interrupted through the relay contact except, perhaps, for a relay contact bounce during the momentous impact upon hitting the ground if the poles on which the units were mounted were destroyed. The breaks in the cable sheaths might result in moisture damage later on if not repaired. (One cable transfer relay was installed in a manhole, (Test Group 96) and

TABLE 3.3 - Damage Summary

Field Wire WD-1TT - Radial Pole Line - Test Group 1 (Shot 9)

Pole Numbers	Ft from GZ	cal	psi	Thermal Damage	Blast Damage	Remarks
D-52	1250	113	16.6	S	S	Wire fused with conductors exposed at field ties on poles. Wire broken and blown from poles.
D-42	2750	63	10.8			
D-41	2900	60	10.6	M	N	Moderate fusing of wires. Some of wire broken and blown from poles.
D-38	3350	52	9.8			
D-37	3500	49	9.4	M	N	Wire in open span beginning to show slight fusing of nylon covering. Conductors exposed at field ties on poles.
D-36	3650	46.5	9.0	L	N	
D-29	4640	32.5	6.8			Nylon covering on wire burned.
D-28	4750	31	6.6	L	N	Nylon covering on wire at field ties burned. No burning of Nylon covering noted in span.
D-22	5730	24	5.2	N	N	Negligible
D-1	9080	8.0	3.0			

three relays were mounted on the transverse pole lines (Test Groups 24, 27, and 30).

(12) JUNCTION BOXES AND TERMINAL STRIPS: The junction boxes and terminal strips received no thermal or blast damage.

(13) FIELD TELEPHONES: The EE-8 field telephones received negligible damage on any of the pole lines. None was placed on poles closer than 3425 ft from GZ. In all instances these field telephones were placed on the side of the pole away from GZ, and were almost completely shielded from heat.

c. PHOTOGRAPHS: The pre- and postshot photographs of these test groups have been combined with those of Test Group 1A for purposes of comparison and are shown in Figs. 3.1 through 3.24.

3.2.2 Radial Pole Line, Test Group 1A, Shot 10 (Figs. 3.1 through 3.24)

a. DESIGN: The radial pole line used in Shot 9 was rehabilitated and used in Shot 10.

b. RESULTS: The pole line as a whole received severe damage from pole D-52 (600 ft, over 65 cal, over 115 psi), out to and including pole D-37 (2900 ft, 47.5 cal, 5.0 psi). In this section of the line 16

poles were splintered at the base of the poles, broken or disintegrated into one or more pieces and blown about the area along the pole line. There was a miscellaneous conglomeration of crossarms, pins, insulators, open wire, lead covered cable, rubber covered cable, spiral four cable, and field wire snarled together along this section of the pole line. The degree of severe damage stopped abruptly at pole D-36. Damage summaries are shown in Table 3.4.

(1) CROSSARMS: All crossarms from pole D-52 (600 ft, 65 cal, over 115 psi) through pole D-37 (2900 ft, 47.5 cal, 5 psi) were ripped from the poles or broken in landing on the ground. Many of the crossarms were broken and thrown as much as 450 ft from their original positions. There was slight thermal burning on all crossarms which decreased in intensity out to the distant end of the pole line (pole D-1, 8350 ft, 5.5 cal, 1.0 psi).

(2) INSULATOR PINS: Insulator pins from Pole D-52 through D-37 received severe damage. No insulator pins were damaged from pole D-36 through pole D-1.

(3) GLASS INSULATORS: All glass insulators were either melted, broken or blown about the area from pole D-52 through pole D-37. Insulators on poles from D-36 through D-1 received varying degrees of thermal damage causing them to darken. The extent of this darkening diminished toward the distant end of the line. No tests were made to determine whether or not this darkening affected their insulation properties.

(4) GUYS and ANCHORS: The triple dead end guys on pole D-52 and the fourway storm guys on Pole D-41 were twisted and on the ground at their original positions. The back guys on poles D-28, D-14 and the triple guys on pole D-1 were slightly loosened. The side and front guys on pole D-1 were taut. The anchor rods for poles D-52 and D-41 were slightly protruded but otherwise in the ground.

(5) OPEN WIRE: The 104 CS wires between poles D-52 (600 ft, over 65 cal, over 115 psi) and D-37 (2900 ft, 47.5 cal, 5 psi) were broken and snarled up in the vicinity of the pole line and received severe damage. From pole D-36 (300 ft, 42 cal, 5.0 psi) to pole D-1 (8350 ft, 5 cal, 1 psi), the open wire was blackened and abnormally sagged. The clearance at transposition crossovers was reduced considerably, and high winds would have caused intermittent short circuits. The open wire circuits would have been operable subsequent to minor repairs to this portion of the pole line.

(6) 26 PAIR LEAD COVERED CABLE: From pole D-52 (600 ft, over 65 cal, over 115 psi) through pole D-37 (2900 ft, 47.5 cal, 5 psi), the lead covered cable was melted, broken and snarled up on the ground in the vicinity of the pole line and received severe damage. From pole D-36 (3000 ft, 43 cal, 5 psi) to pole D-1 (8350 ft, 5 cal, 1 psi) there was slight scorching and roughening of the cable decreasing in intensity toward the distant end of the pole line. This cable showed considerable darkening under the suspension clamps from pole D-36 to pole D-1. The cable splices showed no apparent damage. The lashing wire and messenger wire were intact from poles D-36 through D-1. This cable would have been operable in the section of the line from poles D-36 through D-1.

(7) 5 PAIR RUBBER COVERED CABLE: This cable was burned, broken and snarled up on the ground between pole D-52 (600 ft, 47.5 cal,

TABLE 3.4 - Damage Summary

Poles - Radial Pole Line - Test Group 1A (Shot 10)

Pole Numbers	Ft from GZ	Cal	psi	Thermal Damage	Blast Damage	Remarks
D-52	600	over 65	over 115	S	S	All poles D-52 through D-37 splintered at their bases, broken, splintered and/or disintegrated into a number of pieces and blown about the area. An 8 ft section of pole D-43, very badly splintered, was found 75 ft from the spot where pole D-41 once stood.
D-37	2900	47.5	5.0			
D-36	3000	43	50	M	L	Pole considerably charred on GZ side. Pole good except for a 3 ft rake away from GZ and slightly scraped 9 ft from ground on GZ side. There was a 2 in. gap at base of pole.
D-35	3140	41	5.0	L	L	Pole slightly charred on GZ side. Pole has 30 in. rake away from GZ and a 2 in. gap at base of pole.
D-34	3300	37.5	5.0	L	L	Light charring on GZ side of pole. Pole has 15 in. rake away from GZ.
D-33	3450	34.5	5.0	L	L	Light charring on GZ side of pole. Pole has 1 ft rake away from and a 6 in. rake to right of GZ.
D-32	3600	30	4.5	N	N	Slight charring of poles. Less than 6 in. rake away from GZ.
D-30	3930	27	4.0			
D-29	4030	26	4	N	L	Pole split from through bolt on crossarm to suspension clamp on 5 pr R. C. cable about 1/8 in. to 1/4 in. gap.
D-28	4150	24.5	4	N	N	Back guy of 4 way storm guy loose.
D-27	4340	22	4	N	N	Negligible.
D-22	5100	17	3			
D-21	5250	16	2.5	N	L	1/4 in. to 1/2 in. split in pole from ground to 10 ft height.

TABLE 3.4 - Damage Summary (Continued)

Poles - Radial Pole Line - Test Group 1A (Shot 10)

Pole Numbers	Ft from GZ	Cal	psi	Thermal Damage	Blast Damage	Remarks
D-20	5440	14.5	2.5	N	N	Negligible.
D-15	6165	11.5	2.0			
D-14	6350	10.5	2.0	N	N	Back guy of 4 way storm-guy loose slight gap at base of pole.
D-13	6480	10.5	2.0	N	N	Negligible.
D-12	6625	9.5	2.0	N	L	1/4 in. crack from base of pole to 10 ft height.
D-11	6780	9	1.5	N	N	Negligible.
D-2	8150	6	1.0	N	N	Negligible.
D-1	9080	5.5	1.0	N	N	Slight scorching of pole on GZ side.

NOTE: All poles showed some separation from the ground at the base of the poles varying from 2 in. at pole D-36 to 1/4 in. at pole D-1.

5 psi) and pole D-37 (2900 ft, 47.5 cal, 5 psi) and received severe damage. From pole D-36 to pole D-1 there was scorching and roughening of the cable, and darkening under the suspension clamps, decreasing in intensity toward the far end of the line. The messenger and lashing wire were intact. The cable was considerably slackened from the normal but would have been operable in this section of the line.

(8) SPIRAL FOUR CABLE CX-1065/G: This cable was melted, broken and snarled up on the ground between pole D-52 (600 ft, over 65 cal, 5 psi) and pole D-37 (2900 ft, 47.5 cal, 5 psi) and received severe damage. This cable showed some scorching and roughening along the cable and darkening under the suspension clamps from pole D-36 to D-1. The cable connectors did not part. There was some abnormal sag but the cable would have been operable in this section of the line.

(9) FIELD WIRE WD-1/TT: The field wire was melted, fused, broken and snarled up on the ground between poles D-52 (600 ft, over 65 cal, over 115 psi) and pole D-37 (2900 ft, 47.5 cal, 5 psi) and received severe damage. From pole D-36 to pole D-1, the field wire was fused, short circuited, open and badly sagged at intermittent points. None of the field wire circuits would have been operable and complete rehabilitation would have been required. A damage summary of the field wire is shown in Table 3.5.

(10) CABLE TRANSFER RELAYS: No cable transfer relays were available for Shot 10.

(11) JUNCTION BOXES AND TERMINAL STRIPS: The junction boxes and terminal strips between poles D-52 (600 ft, over 65 cal, over 115 psi) and poles D-37 (2900 ft, 47.5 cal, 5 psi) were either broken or blown about the area. Some of these items could not be found after the shot.

TABLE 3.5 - Damage Summary

Field Wire WD-1/TT - Radial Pole Line - Test Group 1A (Shot 10)

Pole Numbers	Ft from GZ	cal	psi	Thermal Damage	Blast Damage	Remarks
D-52	600	over	over	S	S	Wire melted, fused, broken
D-37	2900	65	115			and snarled up on ground. Wire blown about area.
D-36	3000	43	5	S	S	Wire scorched, field ties melted. Wire sagged to ground.
D-35	3140	41	5	S	N	Wire scorched, field ties melted. Wire sagged to 7 ft from ground.
D-34	3300	37.5	5	S	N	Wire blistered at field ties. Wire sagged to 9 ft from ground.
D-33	3450	34.5	5	M	N	Wire scorched in span and at field ties. Wire abnormally sagged.
D-32	3600	30	5	L	N	Wire darkened. Wire sagged to 9-1/2 ft from ground.
D-31	3750	27.	4	L	L	Wire scorched in span and at field ties. One conductor of one pair broken.
D-30	3930	27	4	L	N	Wire scorched in span and at field ties.
D-29	4030	26	4	L	L	Wire scorched in span and at field ties. One conductor of one pair broken; wire sagged to 9-1/2 ft from ground.
D-28	4150	24.5	4	N	L	One conductor of one pair broken.
D-27	4340	22	4	N	N	Negligible.
D-24	4840	18	3.5			
D-23	4975	17.5	3.5	N	L	One pair open at pole D-23; wire sagged to 8-1/2 ft from ground.
D-22	5100	17	3	N	N	Negligible.
D-19	5575	14	2.5			
D-18	5700	13.5	2.0	N	L	5 pairs twisted together at mid-span.
D-17	5860	12.5	2	N	N	Wire sagged to 8 ft from ground.
D-16	6050	12	2	N	N	Negligible.
D-14	6350	10.5	2	N	N	
D-13	6480	10.5	2	N	L	One pair broken.

TABLE 3.5 - Damage Summary (Continued)

Field Wire WD-1/TT - Radial Pole Line - Test Group 1A (Shot 10)

Pole Numbers	Ft from GZ	cal	psi	Thermal Damage	Blast Damage	Remarks
D-12	6625	9.5	2	N	N	Negligible.
D-5	7720	6.5	1			
D-4	7850	6.5	1	N	N	8 pairs wrapped about each other.
D-3	8000	6	1	N	N	Negligible.
D-1	8350	5.5	1			

NOTE: All WD-1/TT wire showed abnormal sag between spans.

(12) FIELD TELEPHONES: The only field telephones used in this test were those at the distant end of the pole line, 8350 ft, 5.5 cal, 1.0 psi. None of the telephones received any damage.

c. PHOTOGRAPHS: The pre- and postshot photographs of this test group have been combined with those of Test Group 1 for purposes of comparison and are shown in Figs. 3.1 through 3.24.

3.3 TRANSVERSE POLE LINES - TEST GROUPS 24, 27, AND 30, SHOT 9 (FIGS. 3.25-3.51)

Pole lines 1050 ft in length identical in composition to the radial pole line were located at distances 3425, 4450, and 5425 ft from GZ. These lines were oriented tangent to circles drawn through these points with their origins at planned GZ. Commercial type transfer relays were mounted 6 ft from the ground on the GZ side of the poles on poles C-4 (3425 ft), B-4 (4450 ft), and A-4 (5425 ft) from GZ. A limited amount of high speed photography was secured.

3.3.1 Transverse Pole Line - Test Group 24, Shot 9 (Figs. 3.25-3.33)

a. DESIGN - This test group was similar to Test Groups 27 and 30.

b. RESULTS - This pole line, 1050 ft in length, 3425 ft from GZ, 50 cal, 9.6 psi received severe damage.

(1) POLES: All eight poles C-1 through C-8 were broken off and thrown to ground. Poles C-1 and C-8, poles which were triple guyed, were broken off about 6 ft from the surface. Poles C-2 through C-7 were broken off at the surface. All poles received severe damage.

(2) CROSSARMS: Several of the crossarms were broken in half at the center and several appeared to be serviceable.

(3) INSULATOR PINS: A number of the insulator pins were pulled out of the crossarms. Those pins remaining in the crossarms were serviceable.

(4) GLASS INSULATORS: Several of the glass insulators were broken. Those not broken were serviceable.

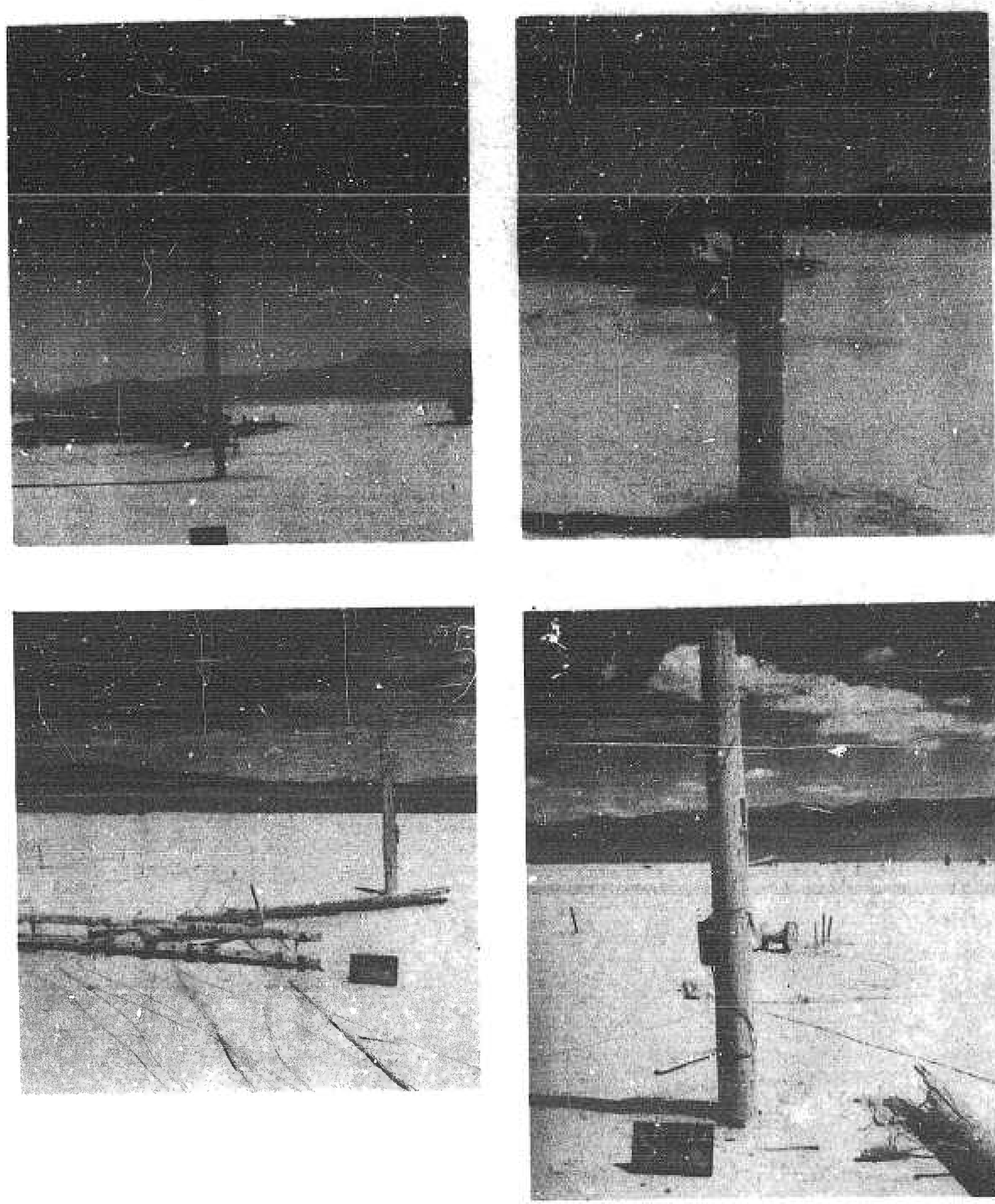
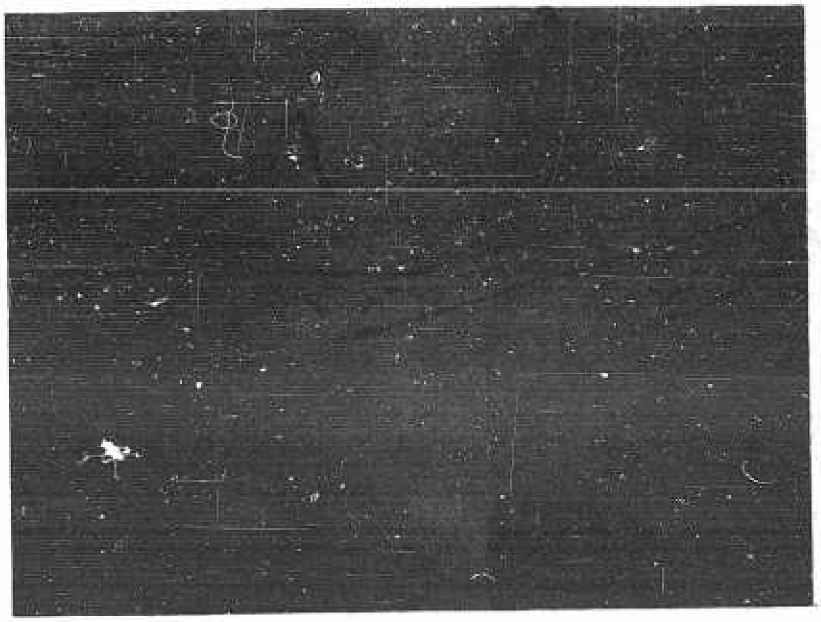


Fig. 3.25 Shot 9, Test Group 24, Transverse Pole Line, Pole C-1. (Top-before, Bottom-after). Close ups of same Pole (Top-before, Bottom-after). 3425 ft, 50 cal, 9.6 psi.



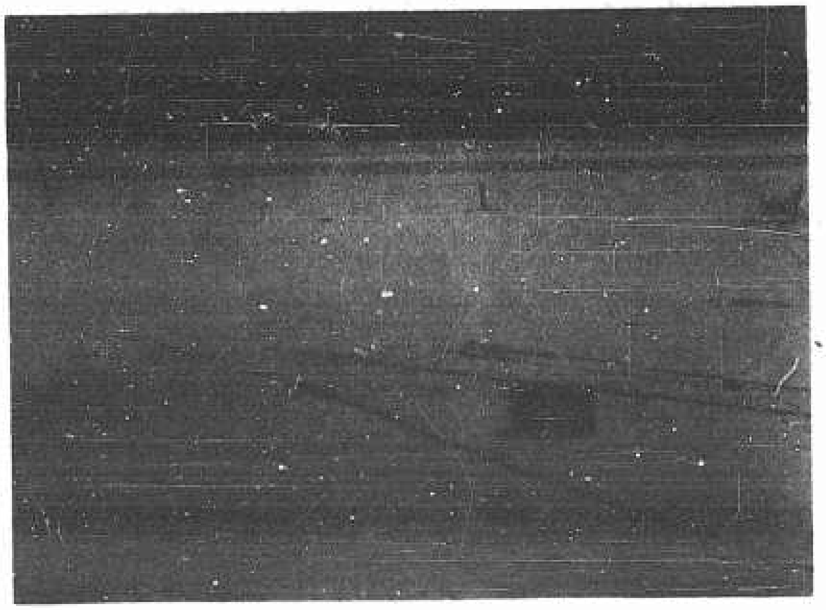


Fig. 3.26 Shot 9, Test Group 24, Transverse Pole Line, Triple Guys and Anchors for Poles C-1. (Top-before, Bottom-after) 3425 ft, 50 cal, 9.6 psi.

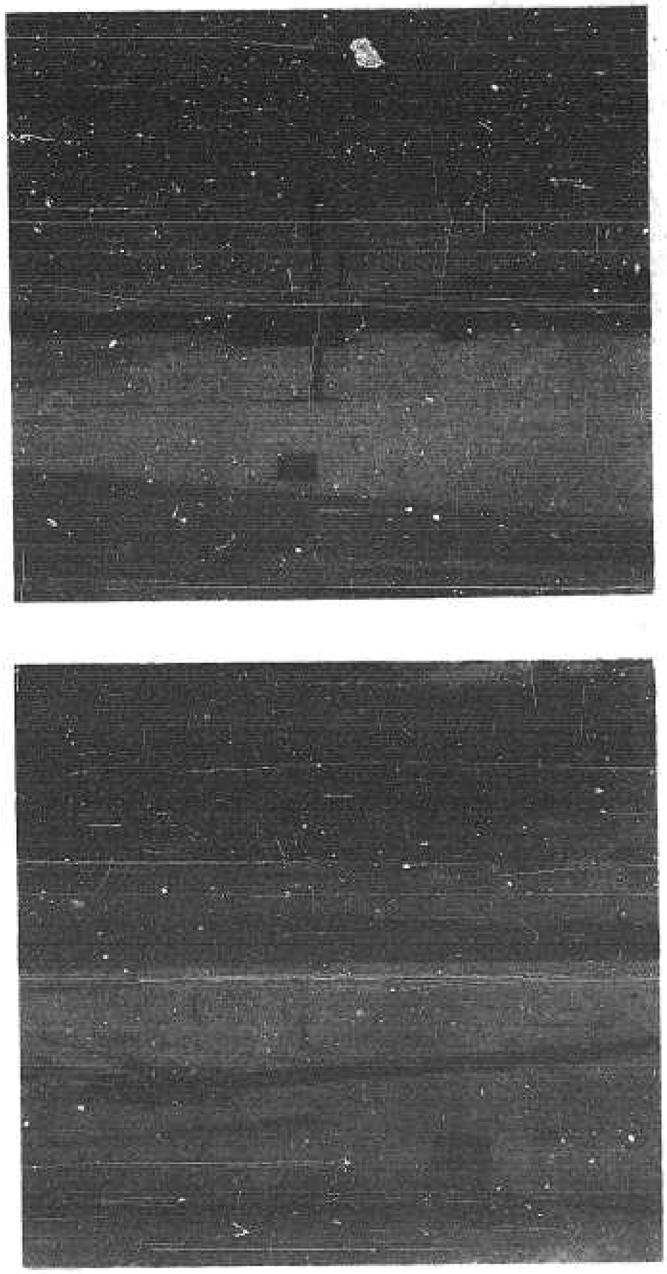


Fig. 3.27 Shot 9, Test Group 24, Transverse Pole Line, Poles C-1 through C-2, C-2 in Foreground. (Top-before, Bottom-after) 3425 ft, 50 cal, 9.6 psi.

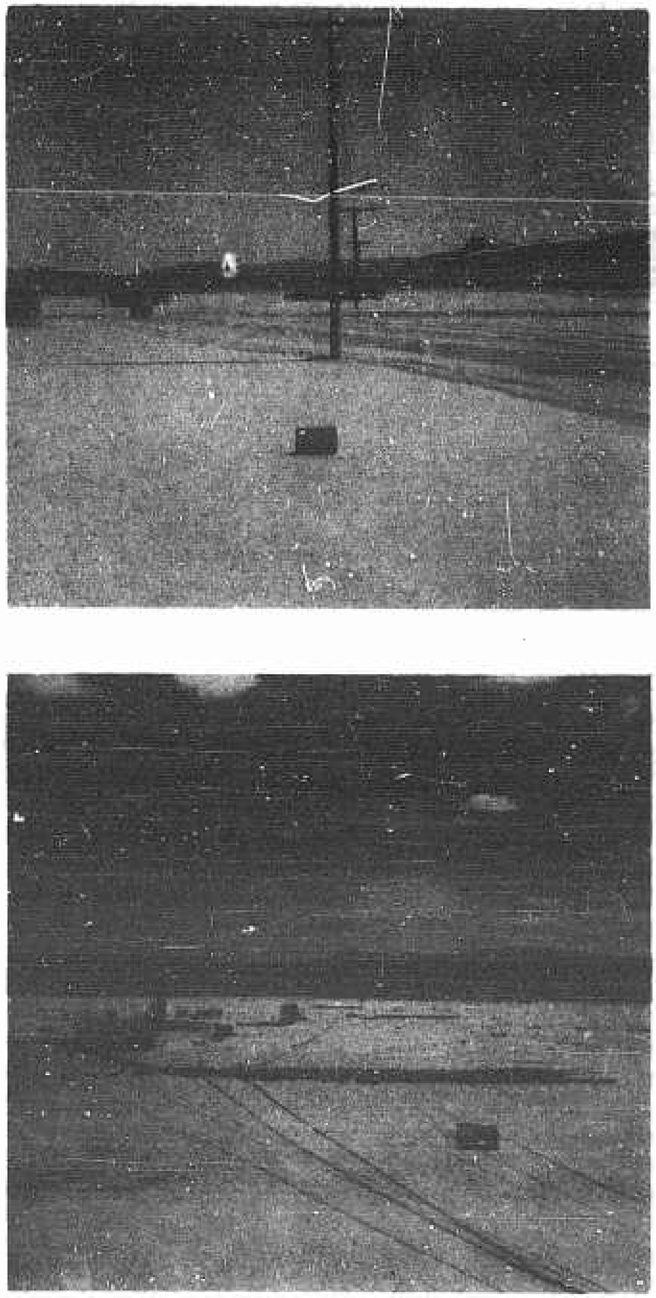


Fig. 3.28 Shot 9, Test Group 24, Transverse Pole Line, Poles C-1 through C-3, C-3 in Foreground. (Top-before, Bottom-after) 3425 ft, 50 cal, 9.6 psi.

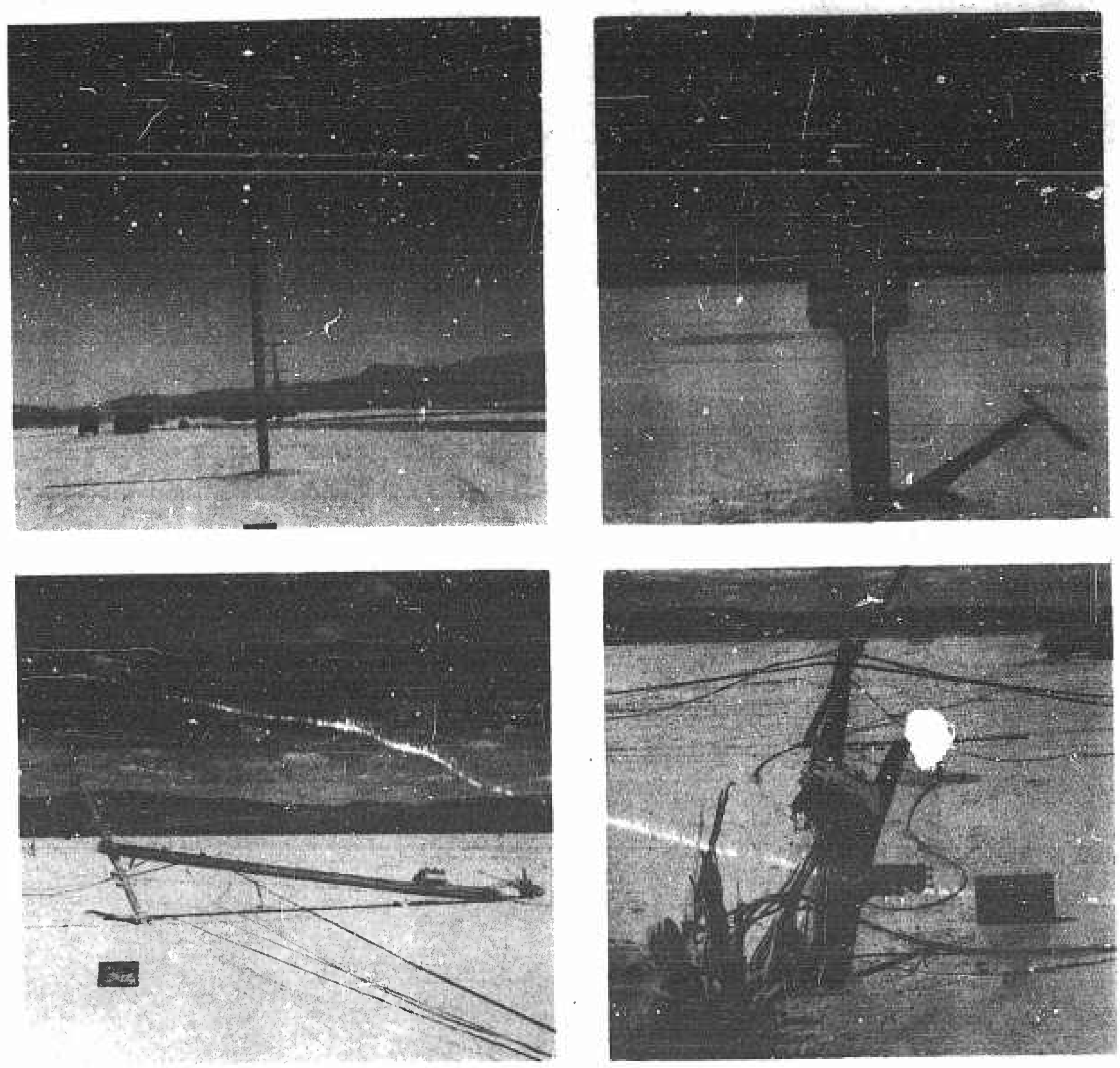


Fig. 3.29 Shot 9, Test Group 24, Transverse Pole Line, Poles C-1 through C-4, C-4 in Foreground. (Top left-before, Bottom left-after, Top right-before, Bottom left-after) Close-ups of Cable Transfer Relay on Pole C-4 (Right). 3425 ft, 50 cal, 9.6 psi.

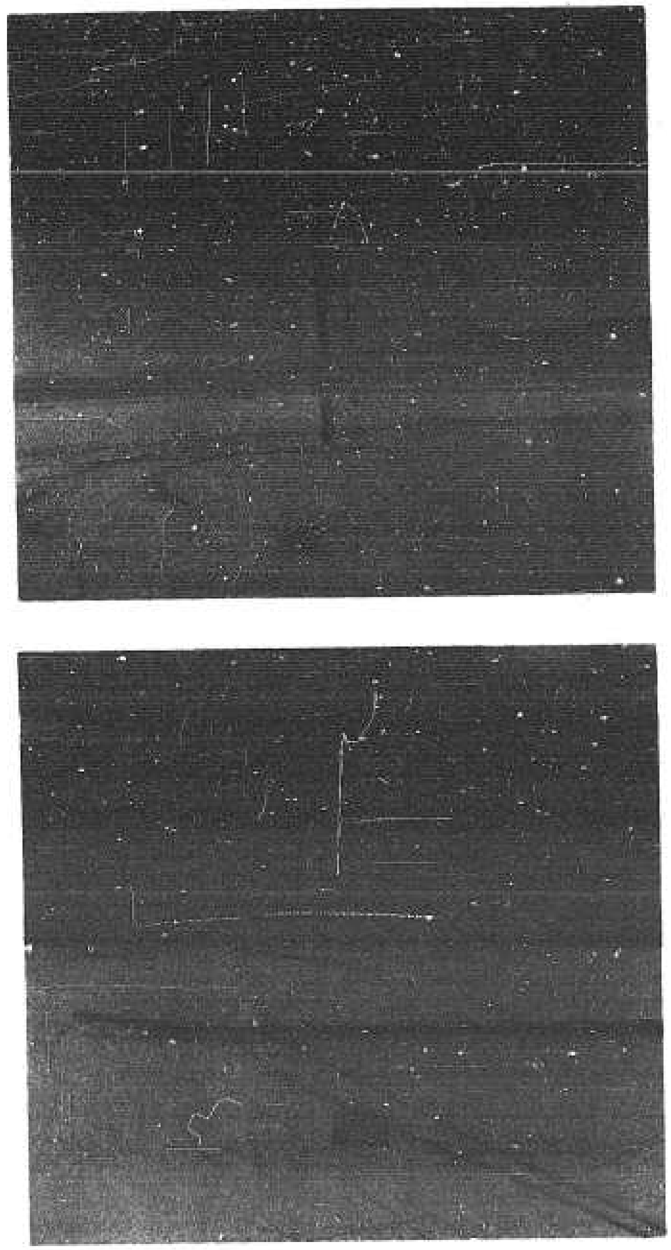


Fig. 3.30 Shot 9, Test Group 24, Transverse Pole Line, Poles C-1 through C-5, C-5 in Foreground. (Top-before, Bottom-after) 3425 ft, 50 cal, 9.6 psi.

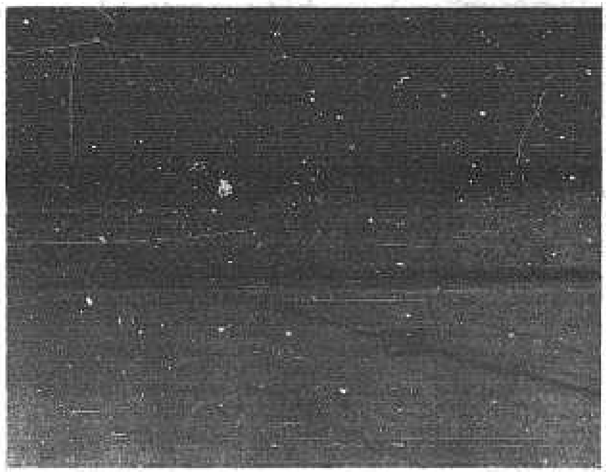


Fig. 3.31 Shot 9, Test Group 24, Transverse Pole Line, Poles C-1 through C-6, C-6 in Foreground. (Top-before, Bottom-after) 3425 ft, 50 cal, 9.6 psi.

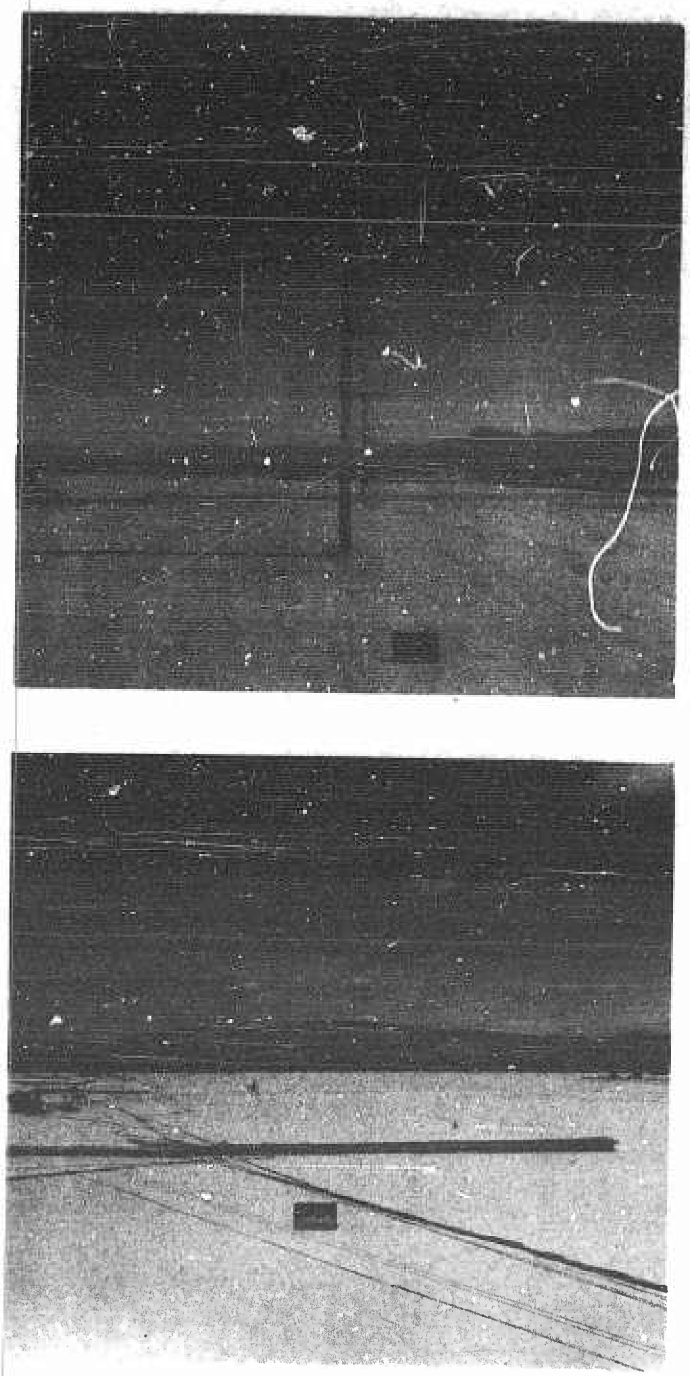


Fig. 3.32 Shot 9, Test Group 24, Transverse Pole Line, Poles C-1 through C-7, C-7 in Foreground. (Top-before, Bottom-after) 3425 ft, 50 cal, 9.6 psi.

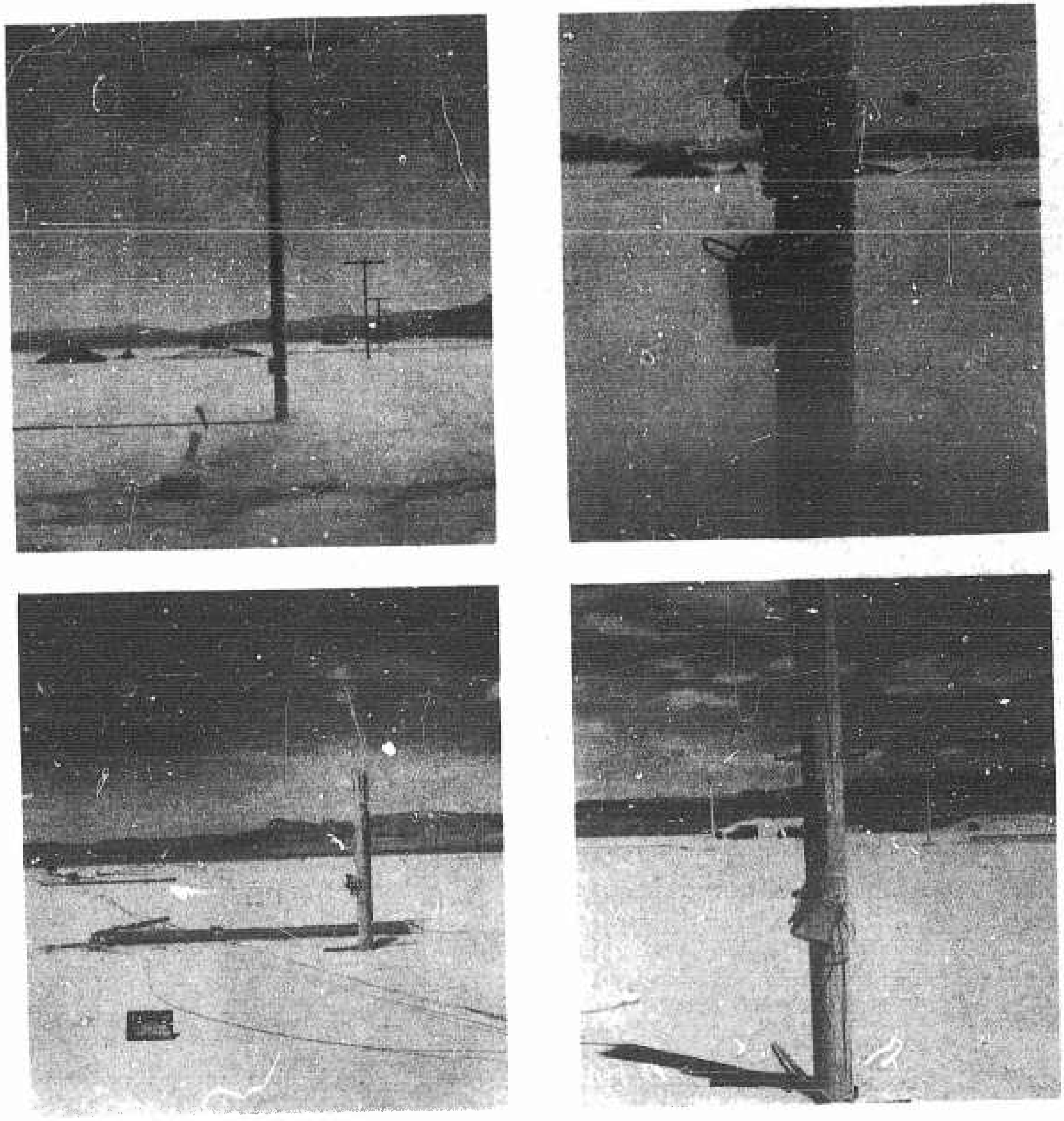


Fig. 3.33 Shot 9, Test Group 24, Transverse Pole Line, Poles C-1 through C-8, C-8 in Foreground. Right Shows Close-ups of EE-8 Telephone and TM-184 Terminal Strip on Shielded Side of Pole C-8. (Top left-before, Bottom left-after, Top right-before, Bottom right-after) 3425 ft, 50 cal, 9.6 psi.

(5) GUYS AND ANCHORS: The triple guys on the two end poles and the anchors were intact and serviceable.

(6) OPEN WIRE: The 104 CS wires although bunched together on the ground were not broken and all would have been useable.

(7) 26 PAIR LEAD COVERED CABLE: This cable was broken in several places and lying on the ground. It remained attached to the messenger on the poles. It received severe damage.

(8) 5 PAIR RUBBER COVERED CABLE: This cable was broken in several places and lying on the ground still attached to the messenger on the poles. It received severe damage.

(9) SPIRAL FOUR CABLE: This cable was broken in several places and lying on the ground attached to the poles. It received severe damage.

(10) FIELD WIRE WD-1/TT: This wire was burned and broken in several places and received severe damage.

(11) CABLE TRANSFER RELAY: The relay mounting brackets were loose on this relay. Several of the capstain nuts which held the cover closed were loosened causing the pressurized air within the relay to be released. A laboratory analysis indicates that this relay received no substantial thermal or blast damage and it would have been serviceable after the shot.

(12) JUNCTION BOXES AND TERMINAL STRIPS: These items sustained no apparent thermal or blast damage.

(13) FIELD TELEPHONES: The field telephones on poles C-1 and C-8 were shielded from the thermal flux and received no significant thermal or blast damage.

c. PHOTOGRAPHS: Pre- and Post-Shots 9 and 10 photographs of this test group are shown in Figs. 3.25 through 3.33.

3.3.2 Transverse Pole Line - Test Group 27, Shot 9 (Figs. 3.34-3.42)

a. DESIGN - This test group was similar to test groups 24 and 31.

b. RESULTS - This pole line, 1050 ft in length, 4450 ft from GZ, 35 cal, 7.0 psi, received severe damage.

(1) POLES: Poles B-1 through B-7 were broken off with stubs remaining. Pole B-8 remained standing but had a severe bend away from ground zero. The pole itself was unserviceable and would require replacement.

(2) CROSSARMS: Several crossarms were broken in half and several would have been serviceable.

(3) INSULATOR PINS: Several of the insulator pins were pulled from the crossarms.

(4) GLASS INSULATORS: The glass insulators received no substantial thermal or blast damage.

(5) GUYS AND ANCHORS: The triple guys and anchors on end poles B-1 and B-8 were intact and serviceable.

(6) OPEN WIRE: The 104 CS wires were bunched together on the ground but none were broken. They would have been serviceable.

(7) 26 PAIR LEAD COVERED CABLE: This cable lying on the ground was broken in several places and received severe damage.

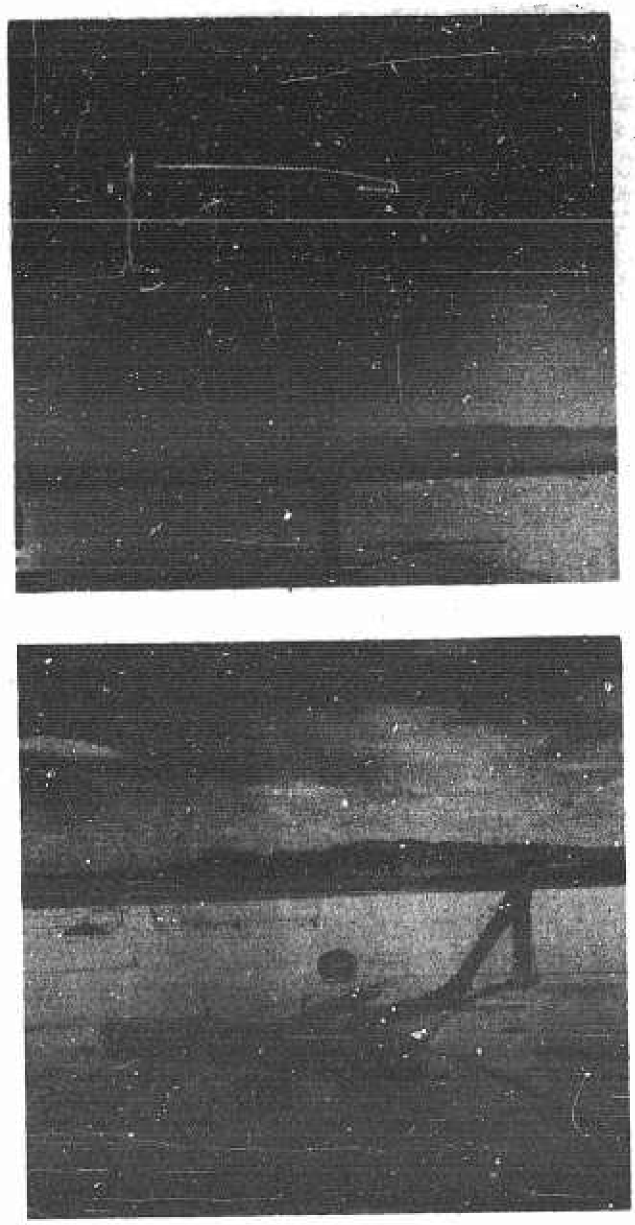


Fig. 3.34 Shot 9, Test Group 27, Transverse Pole Line, Pole B-1. (Top-before, Bottom-after)
4450 ft, 35 cal, 7 psi.

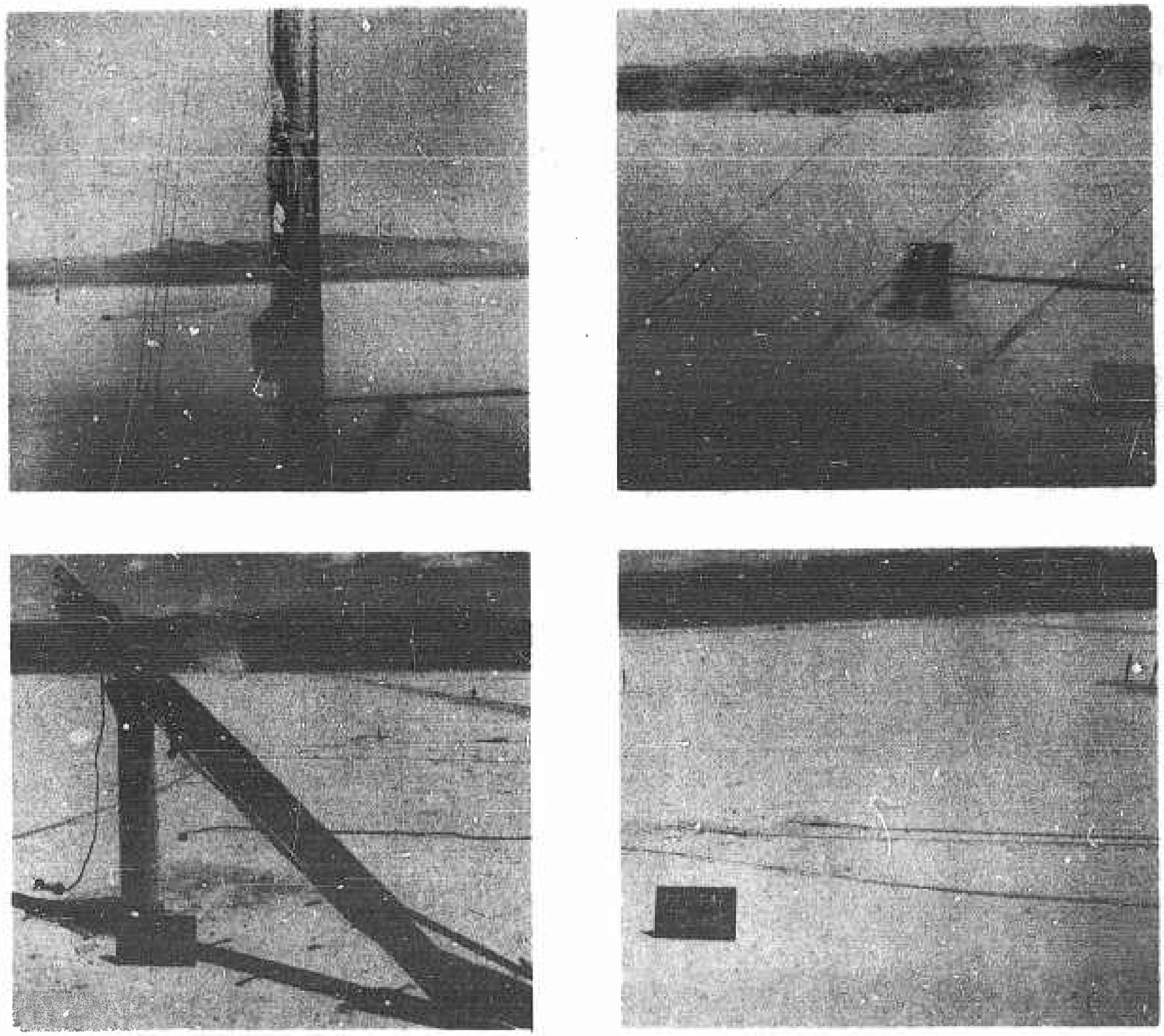


Fig. 3.35 Shot 9, Test Group 27, Transverse Pole Line, Close-up of Pole B-1. (Top-before, Bottom-after) 4450 ft, 35 cal, 7 psi. Right - Close-ups of Triple guys on Pole B-1. (Top-before, Bottom-after)

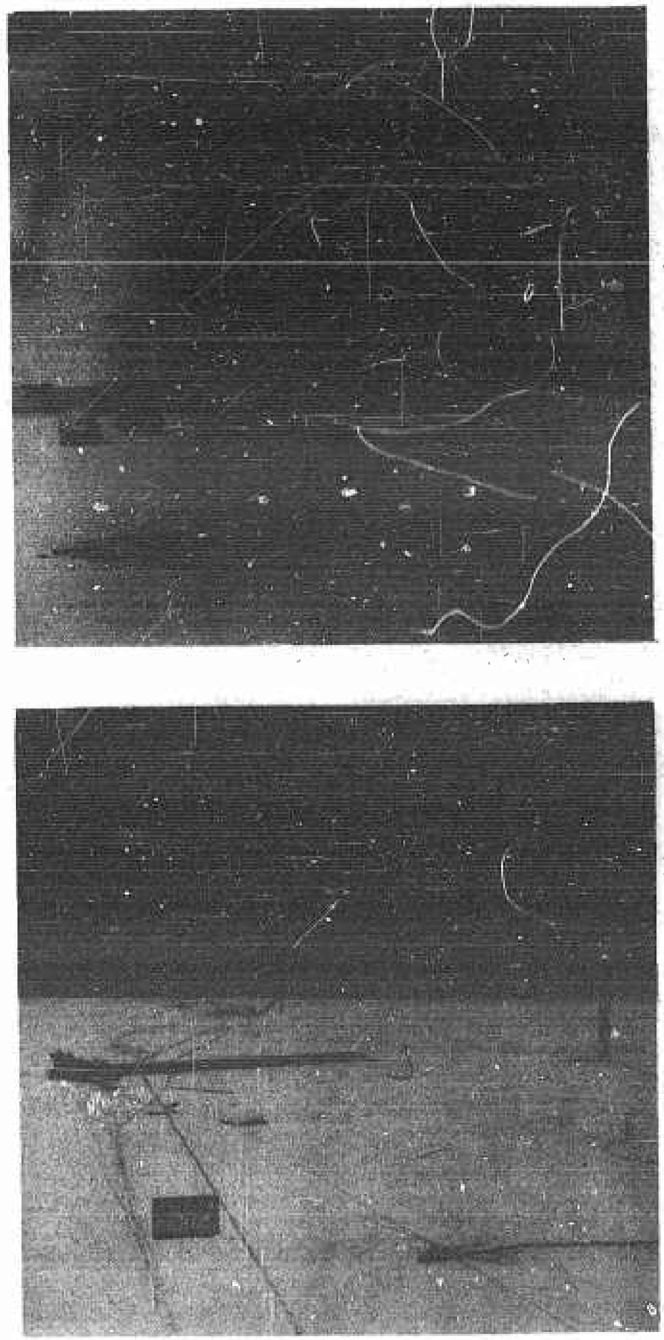


Fig. 3.36 Shot 9, Test Group 27, Transverse Pole Line, Poles B-1 through B-2, B-2 in Foreground. (Top-before, Bottom-after) 4450 ft, 35 cal, 7 psi.

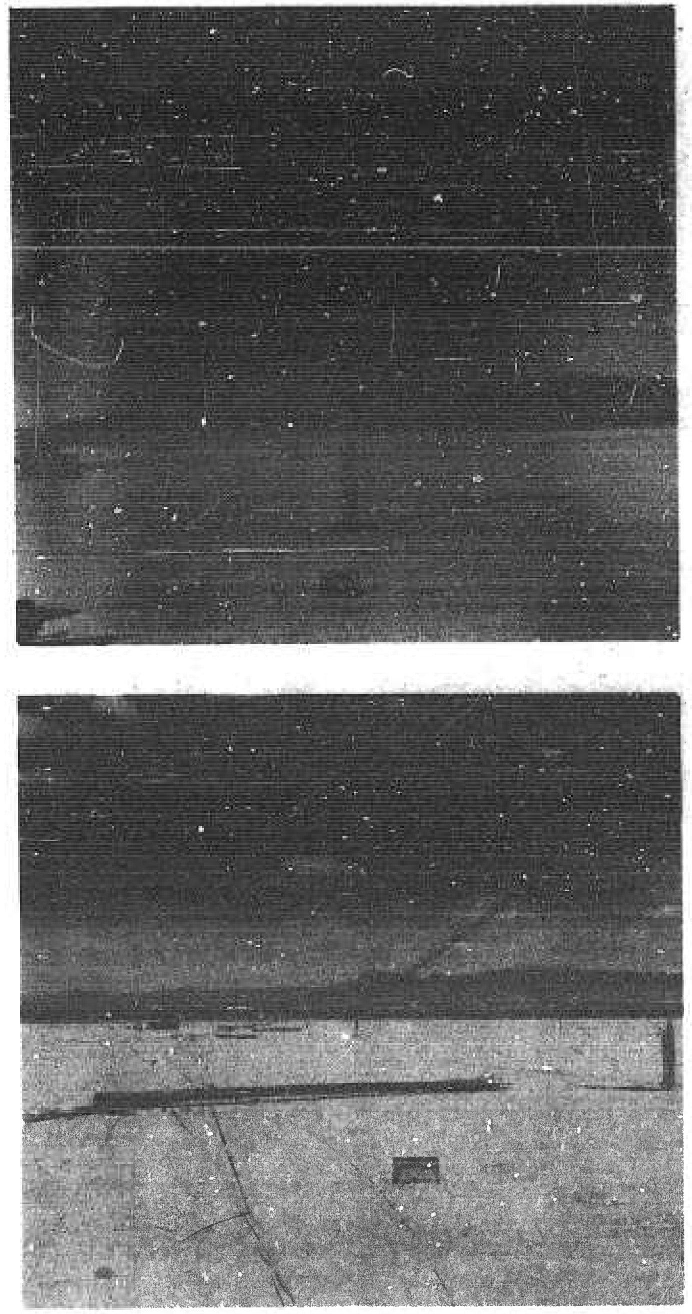


Fig. 3.39 Shot 9, Test Group 27, Transverse Pole Line, Poles B-1 through B-5, B-5 in Foreground. (Top-before, Bottom-after) 4450 ft, 35 cal, 7 psi.

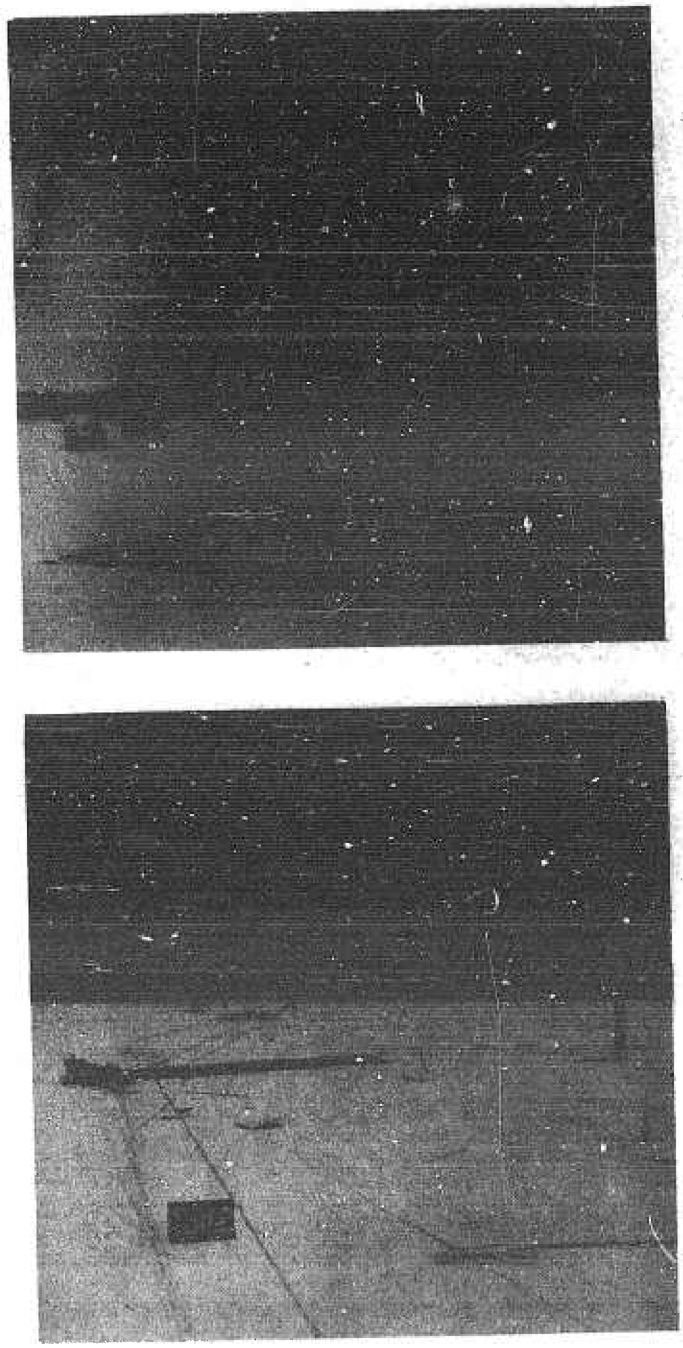


Fig. 3.36 Shot 9, Test Group 27, Transverse Pole Line, Poles B-1 through B-2, B-2 in Foreground. (Top-before, Bottom-after) 4450 ft, 35 cal, 7 psi.

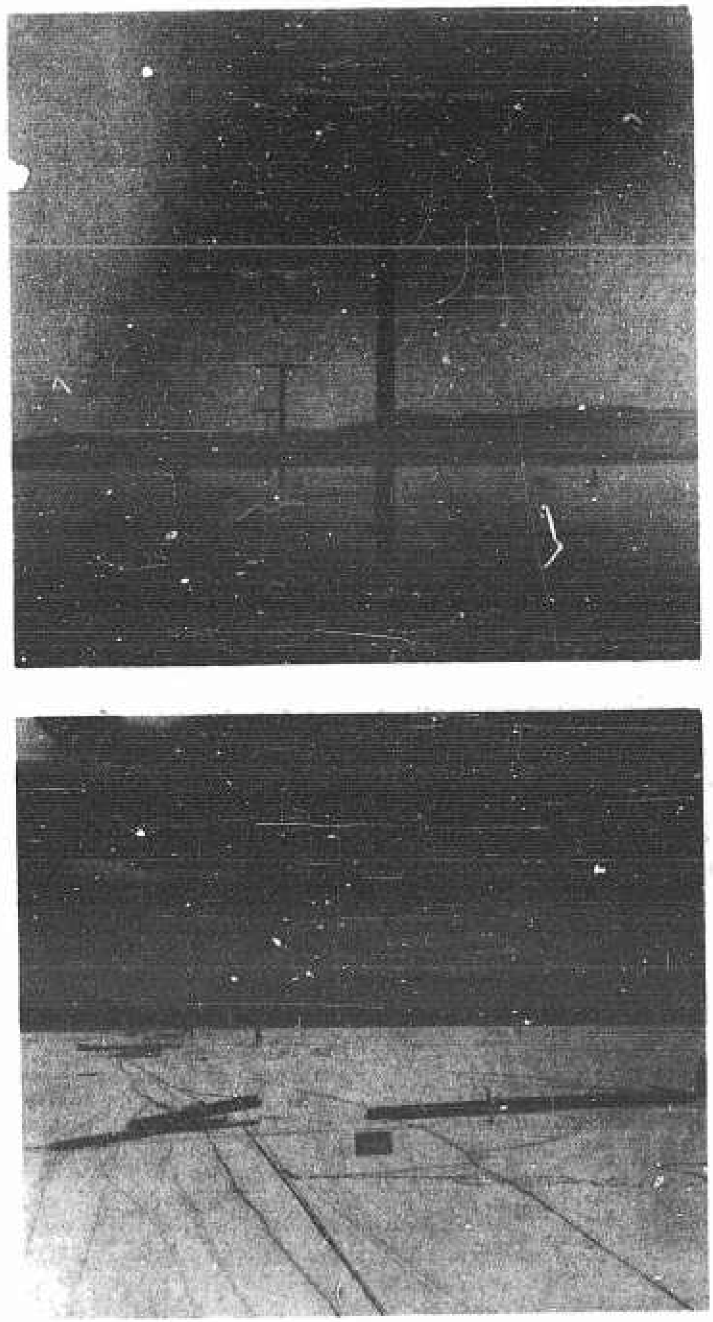


Fig. 3.37 Shot 9, Test Group 27, Transverse Pole Line, Poles B-1 through B-3, B-3 in Foreground. (Top-before, Bottom-after) 4450 ft, 35 cal, 7 psi.

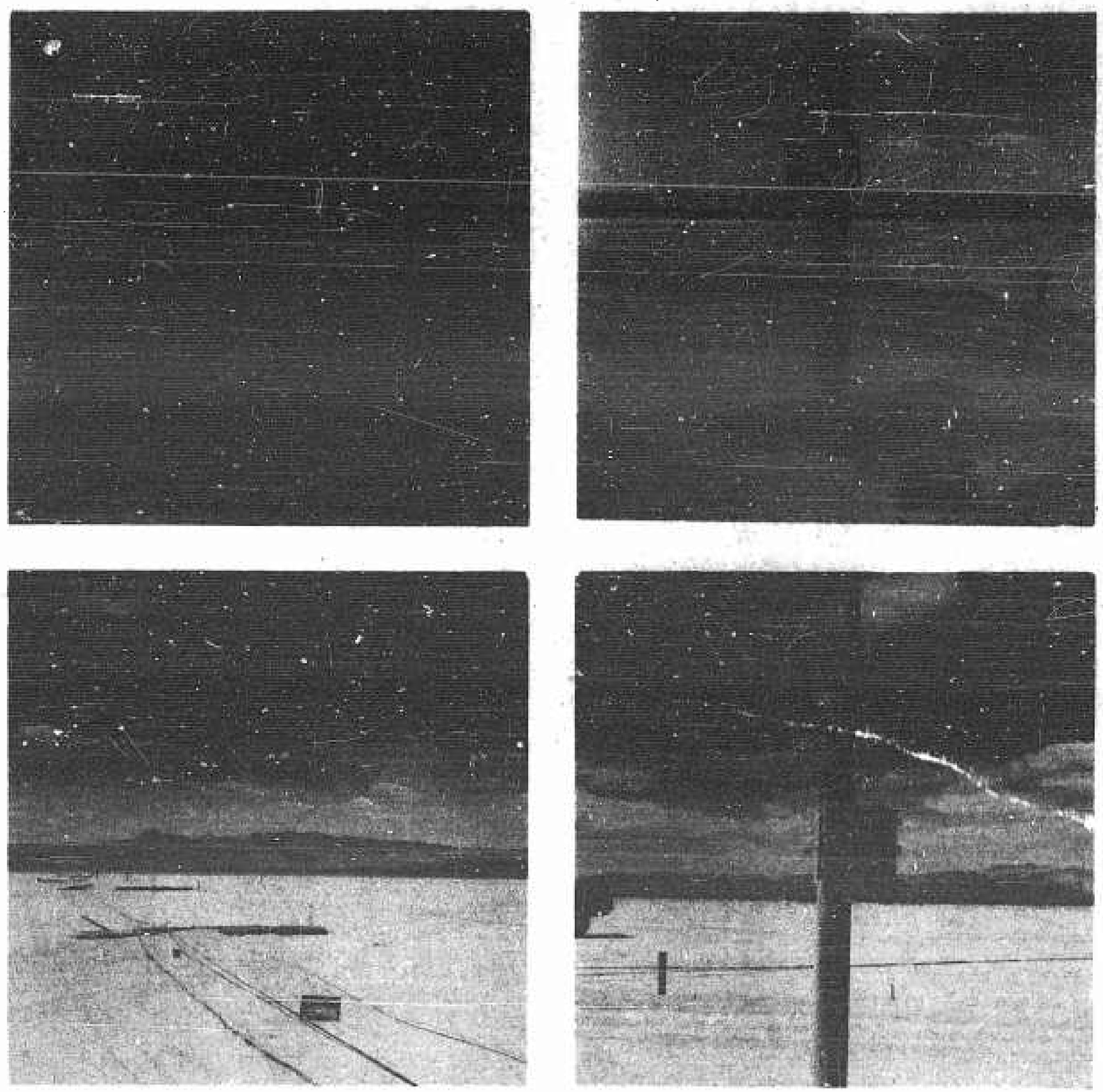


Fig. 3.38 Shot 9, Test Group 27, Transverse Pole Line, Poles B-1 through B-4, B-4 in Foreground. Right Shows Close-ups of Cable Transfer Relay on Pole B-4. (Top left-before, Bottom left-after, Top right-before, Bottom right-after) 4450 ft, 35 cal, 7 psi.

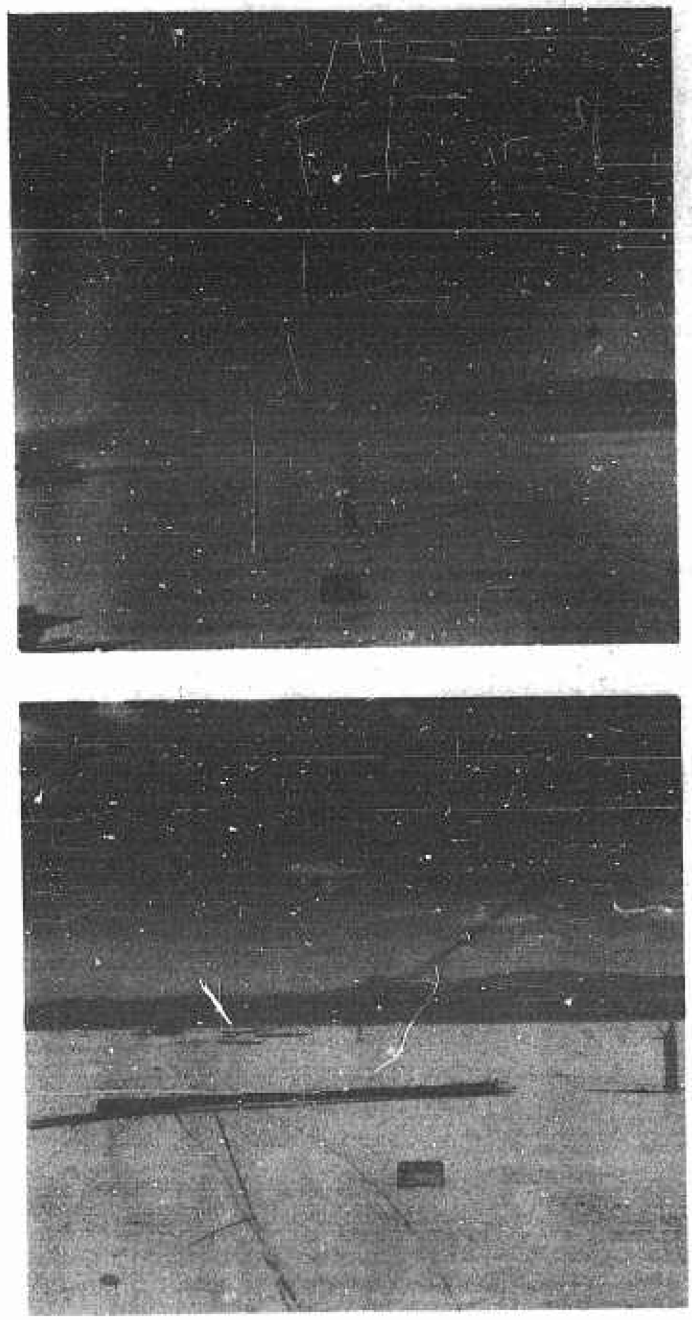


Fig. 3.39 Shot 9, Test Group 27, Transverse Pole Line, Poles B-1 through B-5, B-5 in Foreground. (Top-before, Bottom-after) 4450 ft, 35 cal, 7 psi.

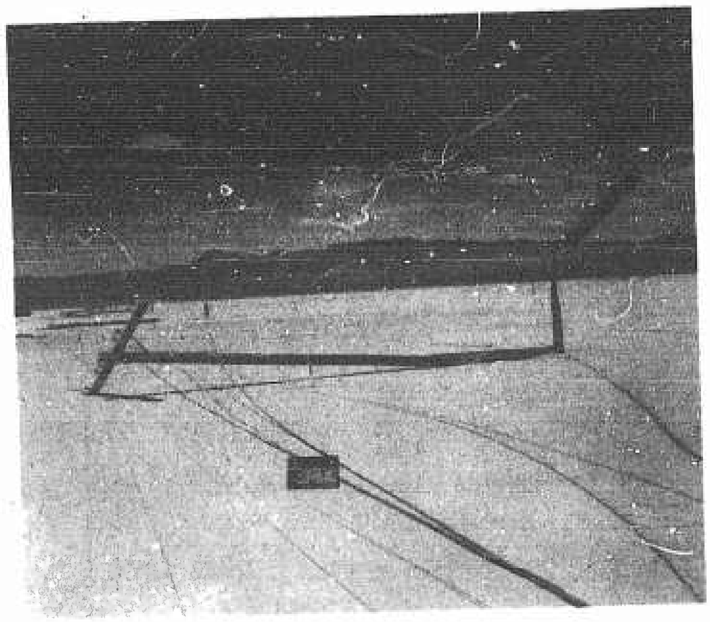


Fig. 3.40 Shot 9, Test Group 27, Transverse Pole Line, Poles B-1 through B-6, B-6 in Foreground. (Top-before, Bottom-after) 4450 ft, 35 cal, 7 psi.

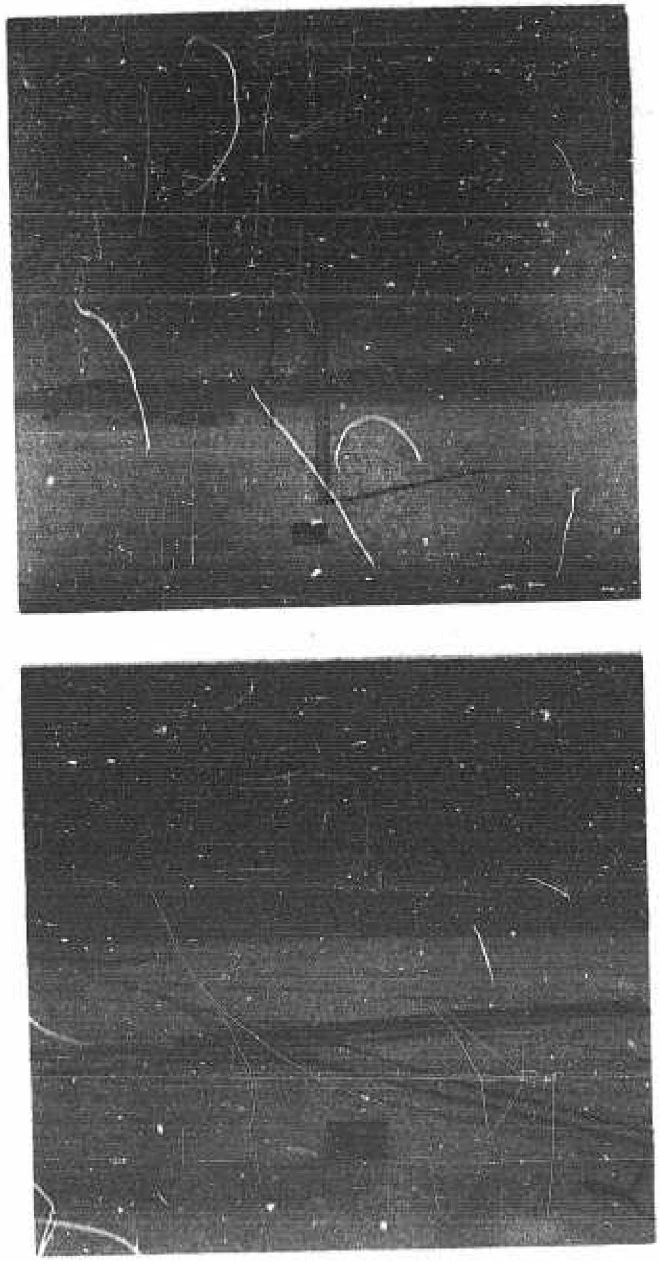


Fig. 3.41 Shot 9, Test Group 27, Transverse Pole Line, Poles B-1 through B-7, B-7 in Foreground. (Top-before, Bottom-after) 4450 ft, 35 cal, 7 psi.

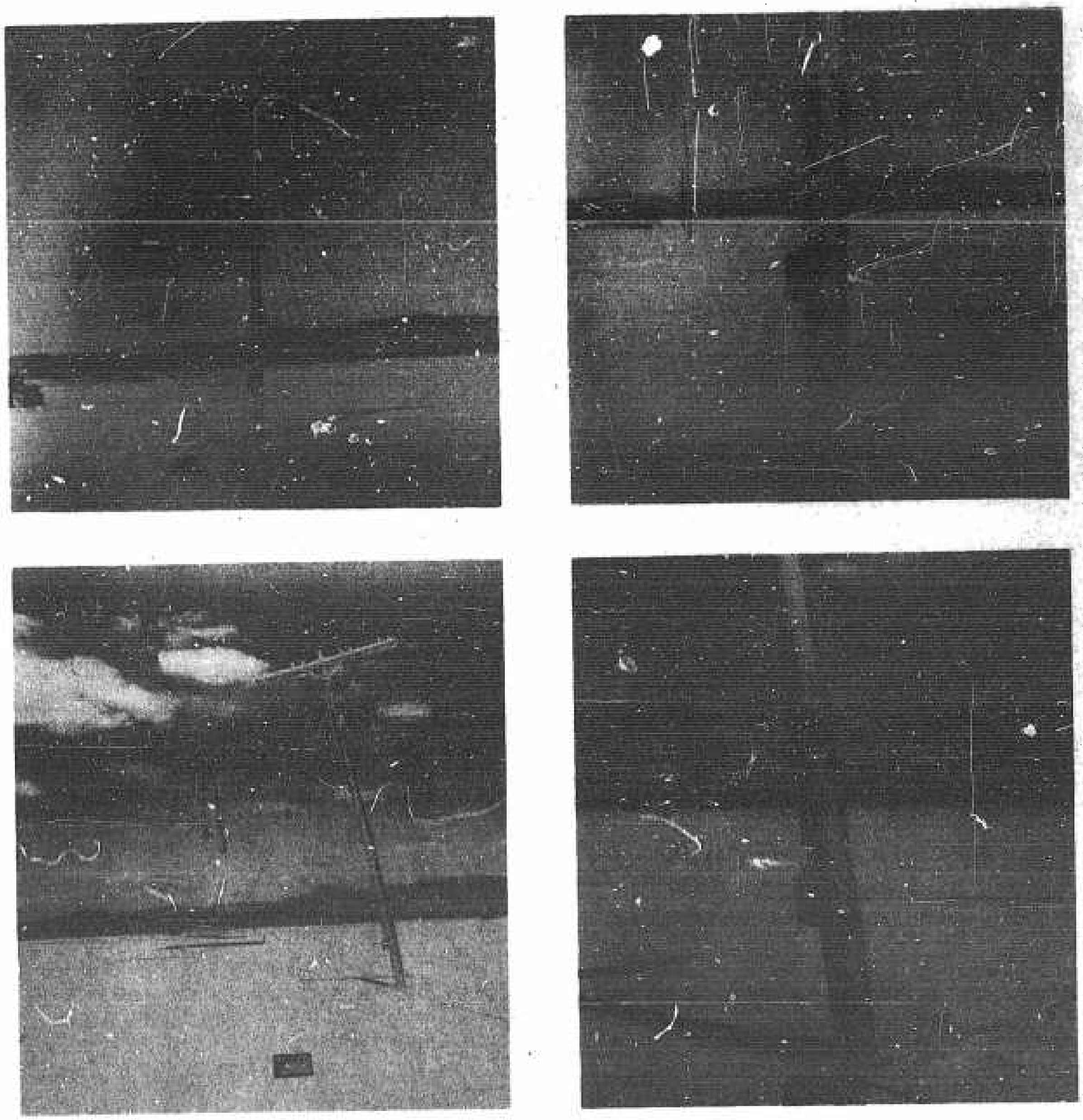


Fig. 3.42 Shot 9, Test Group 27, Transverse Pole Line, Poles B-1 through B-8, B-8 in Foreground. Right Shows Close-ups of EE-8 Telephone and TM-184 Terminal Strip on Shielded Side of Pole B-8. (Top left-before, Bottom left-after, Top right-before, Bottom right-after) 4450 ft, 35 cal, 7 psi.

(8) FIVE PAIR RUBBER COVERED CABLE: This cable lying on the ground was broken in several places and received severe damage.

(9) SPIRAL FOUR CABLE: This cable lying on the ground was broken in several places and received severe damage.

(10) CABLE TRANSFER RELAY: This relay sustained no significant thermal or blast damage. A laboratory analysis performed on this relay shows that there was no electrical or structural damage.

(11) JUNCTION BOXES AND TERMINAL STRIPS: These items received no significant thermal or blast damage.

(12) FIELD TELEPHONES: These items on poles B-1 and B-8 were shielded from the thermal flux and received no significant thermal or blast damage.

c. PHOTOGRAPHS: Pre- and post-Shot 9 photographs of the results are shown in Figs. 3.34 through 3.42.

3.3.3 Transverse Pole Line - Test Group 31, Shot 9 (Figs. 3.43-3.51)

a. DESIGN - This test group was similar in design to Test Groups 24 and 27.

b. RESULTS - This pole line, 1050 ft in length, 5425 ft from GZ, 25.5 cal, 5.6 psi, received moderate damage.

(1) POLES: The two end poles A-1 and A-8 remained standing. Poles A-3, A-4, A-5, and A-6 also remained standing although poles A-4 and A-5 were moderately damaged (splintered) and would require replacement. Poles A-2 and A-7, next to the two end poles, were broken off several feet from the surface. The poles taken as a whole received moderate damage.

(2) CROSSARMS: Several crossarms were broken. Those remaining were serviceable.

(3) INSULATOR PINS: Several of the insulator pins were missing from the double crossarms on pole A-1; all other insulator pins were intact.

(4) GLASS INSULATORS: Several glass insulators were broken and others missing from the crossarms.

(5) GUYS AND ANCHORS: The triple guys and anchors on poles A-1 and A-8 were intact and serviceable.

(6) OPEN WIRE: The 105 CS wires were not broken but were twisted together in the transposition span.

(7) 26 PAIR LEAD COVERED CABLE: This cable was intact on the messenger on the poles and all circuits were operable.

(8) 5 PAIR RUBBER COVERED CABLE: This cable was intact on the messenger on the poles and all circuits were operable.

(9) SPIRAL FOUR CABLE: This self supporting cable was broken in several places due to the pole breakage and received moderate damage.

(10) FIELD WIRE WD-1/TT: The field wire was not damaged by thermal energy but was broken in several places by the blast and received severe damage.

(11) CABLE TRANSFER RELAY: This relay on pole A-4 received no visible damage. A laboratory analysis indicates that this relay received no electrical or structural damage and it would have been serviceable.

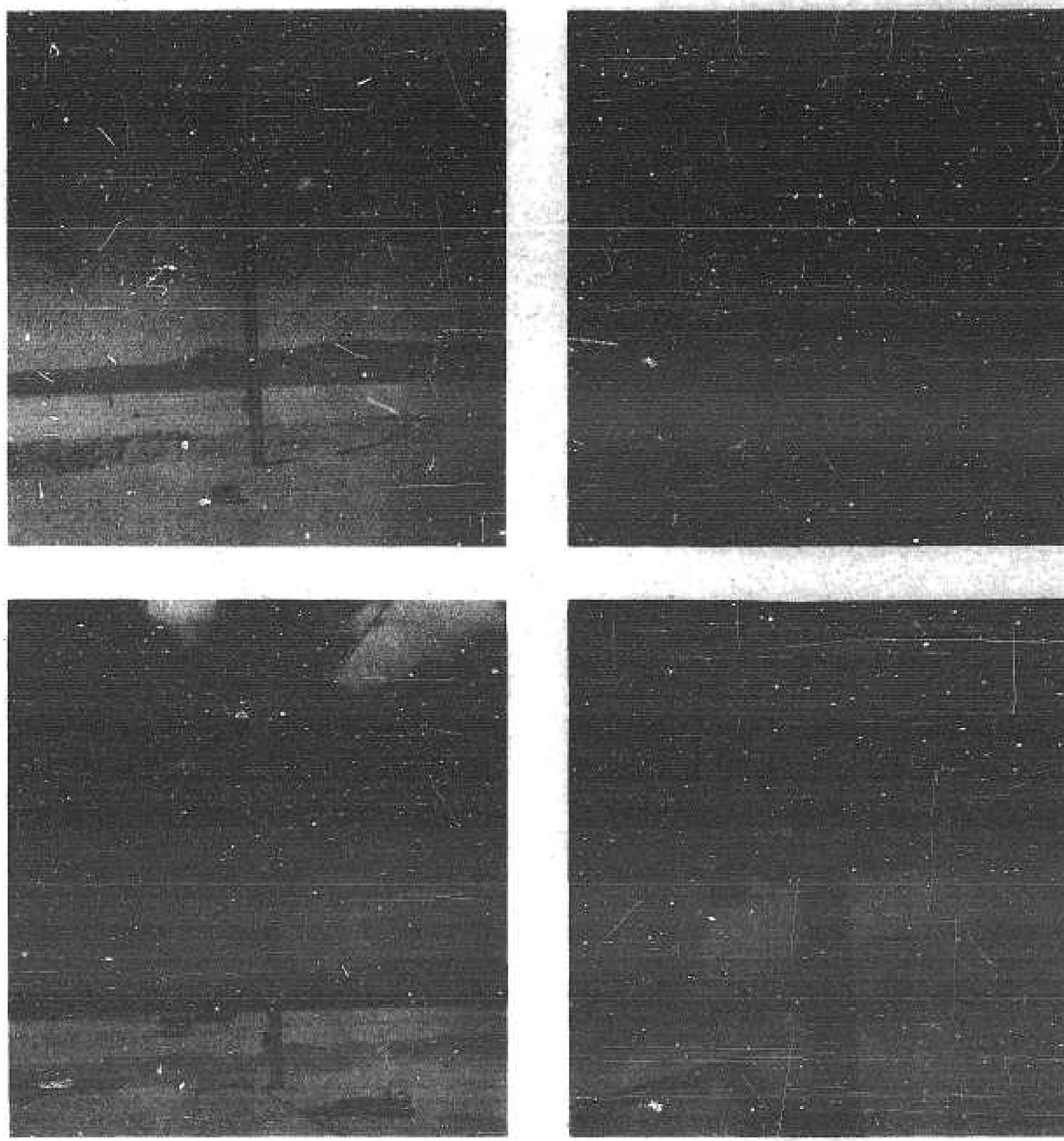


Fig. 3.43 Shot 9, Test Group 30, Transverse Pole Line, Pole A-1. (Top left-before, Bottom left-after) Close-ups of EE-8 Telephone and TM-184 Terminal Strip on Shielded Side of Pole A-1. (Top right-before, Bottom right-after) 5425 ft, 25.5 cal, 5.6 psi.

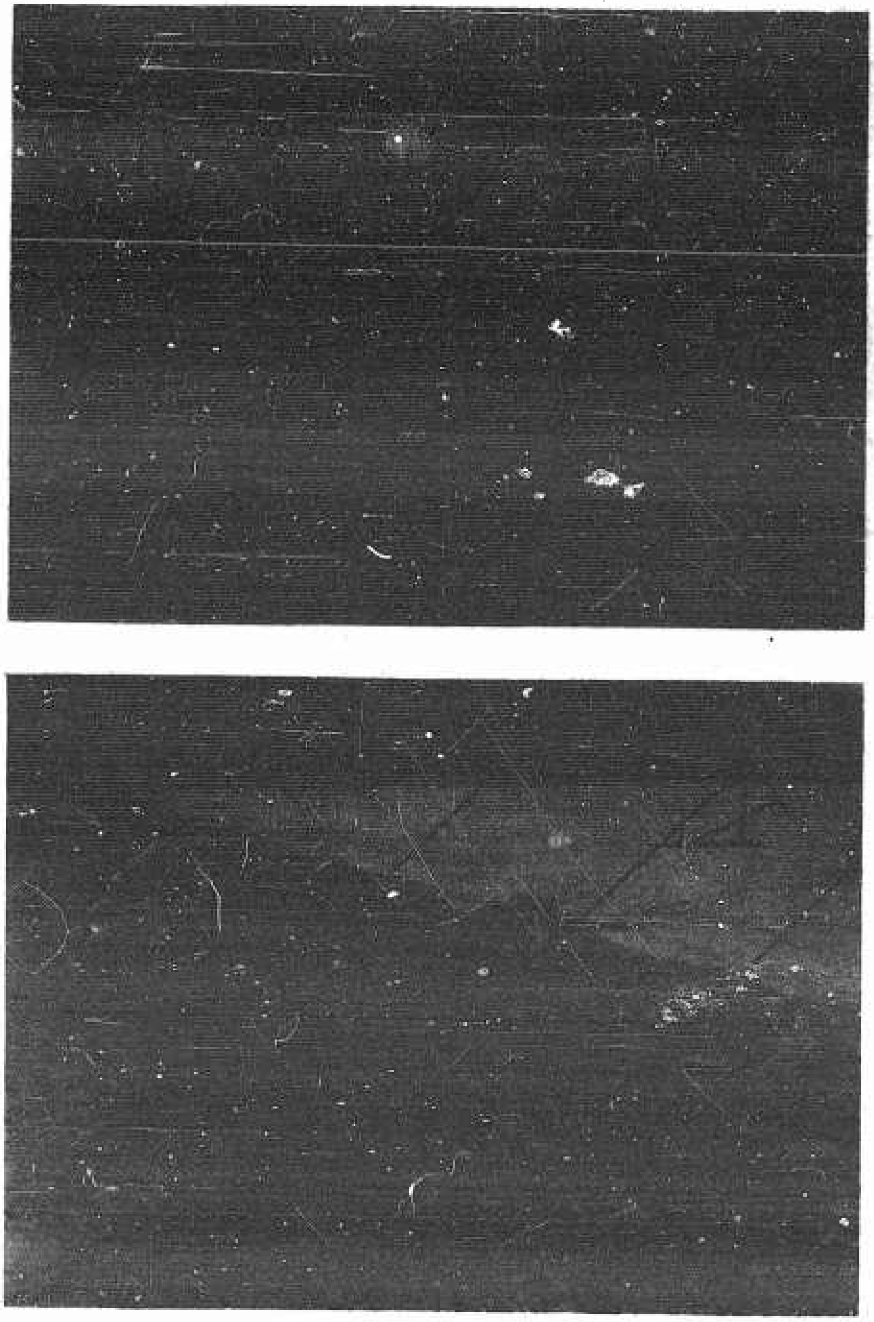


Fig. 3.44 Shot 9, Test Group 30, Transverse Pole Line, Triple Guys and Anchors on Pole A-1. (Top-before, Bottom-after) 5425 ft, 25.5 cal, 5.6 psi.

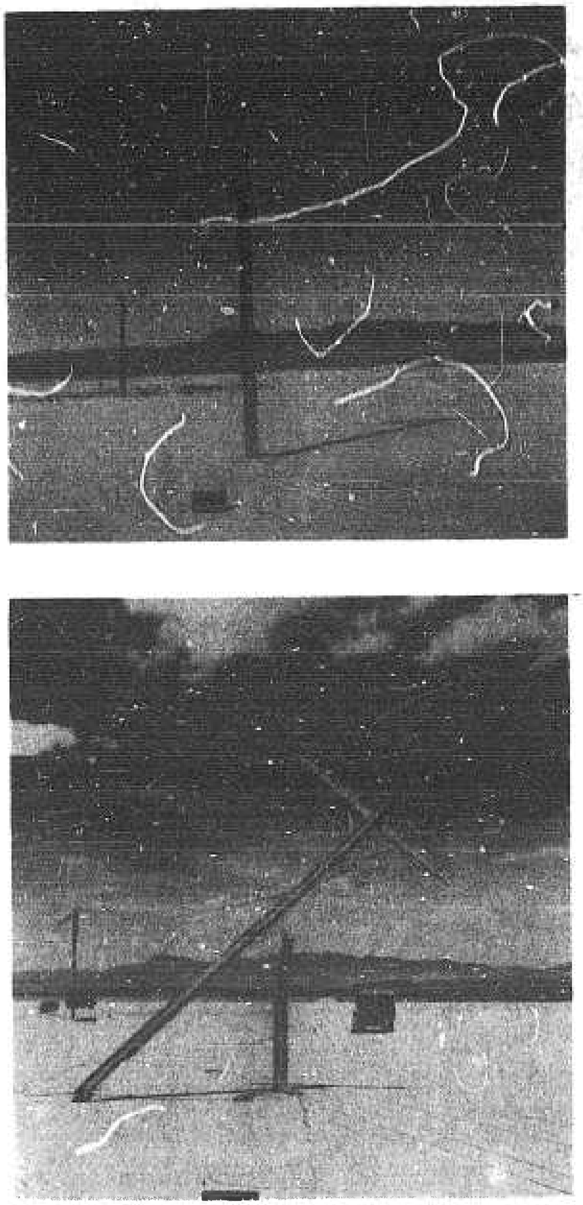


Fig. 3.45 Shot 9, Test Group 30, Transverse Pole Line, Poles A-1 through A-2, A-2 in Foreground. (Top-before, Bottom-after) 5425 ft, 25.5 cal, 5.6 psi.

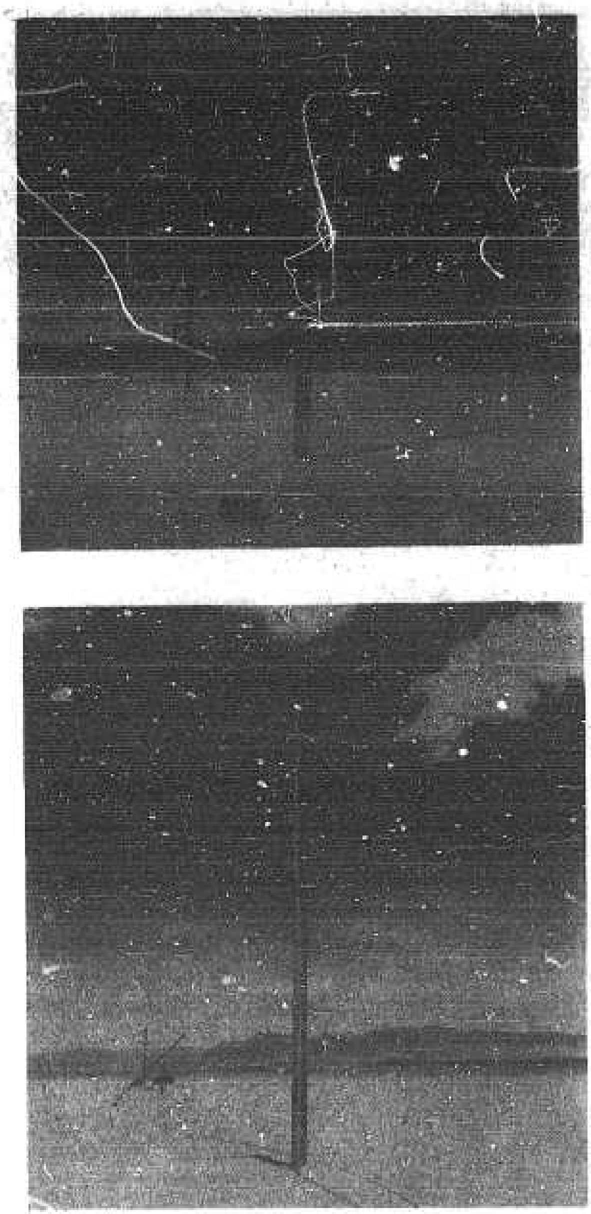


Fig. 3.46 Shot 9, Test Group 30, Transverse Pole Line, Poles A-1 through A-3, A-3 in Foreground. (Top-before, Bottom-after) 5425 ft, 25.5 cal, 5.6 psi.

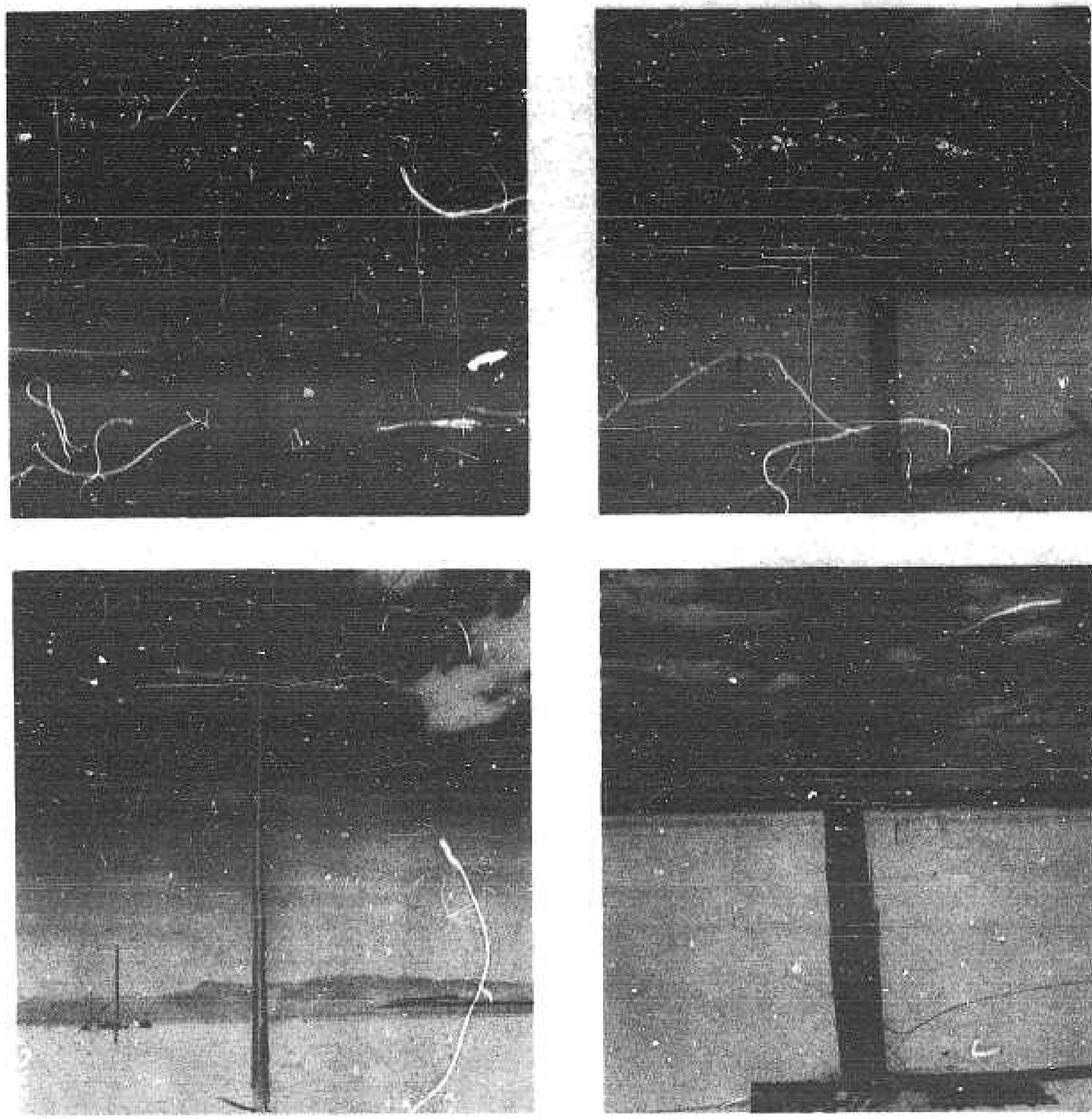


Fig. 3.47 Shot 9, Test Group 30, Transverse Pole Line, Poles A-1 through A-4, A-4 in Foreground. (Top-before, Bottom-after) Right - Close-ups of Cable Transfer Relay on Pole A-4. (Top-before, Bottom-after) 5425 ft, 25.5 cal, 5.6 psi.

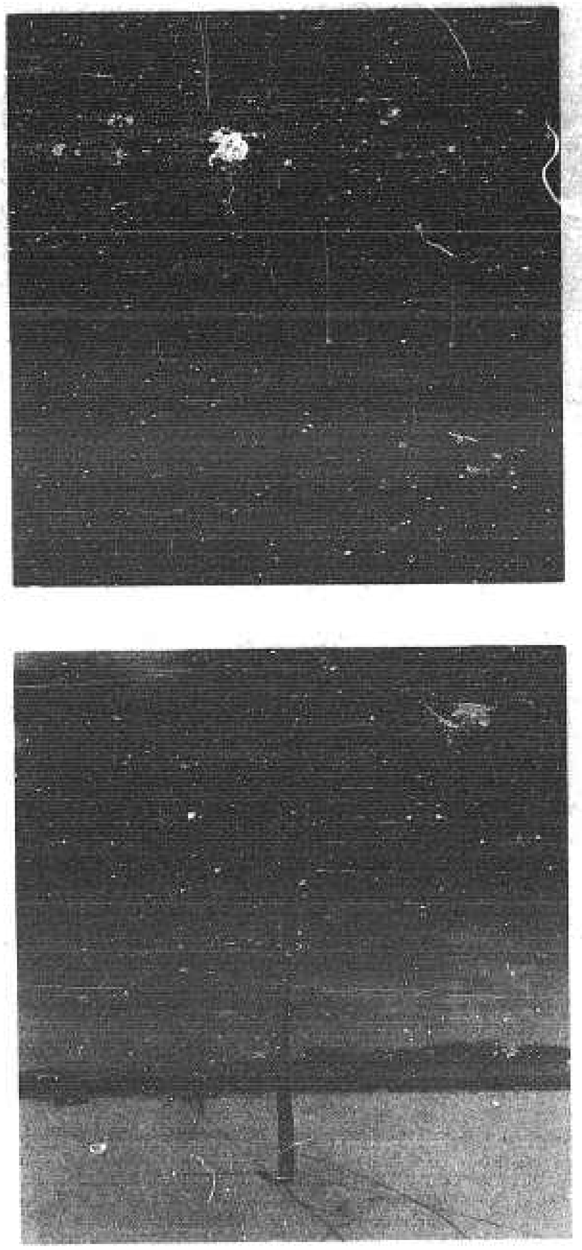


Fig. 3.48 Shot 9, Test Group 30, Transverse Pole Line, Poles A-1 through A-6, A-6 in Foreground. (Top-before, Bottom-after) 5425 ft, 25.5 cal, 5.6 psi.

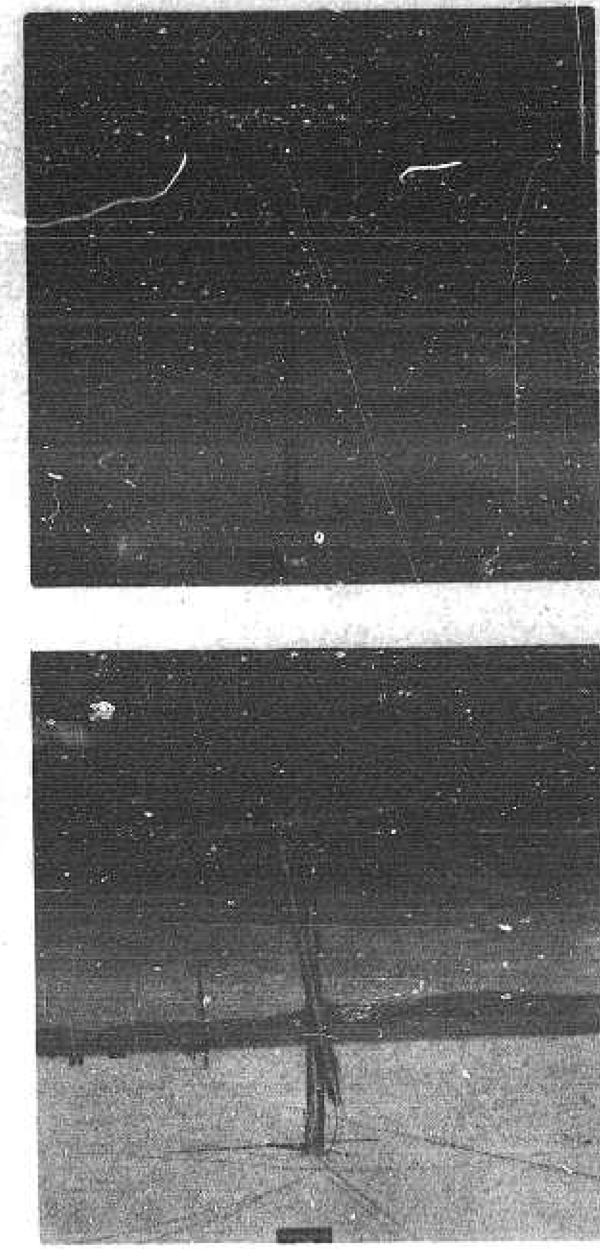


Fig. 3.49 Shot 9, Test Group 30, Transverse Pole Line, Poles A-1 through A-7, A-7 in Foreground. (Top-before, Bottom-after) 5425 ft, 25.5 cal, 5.6 psi.

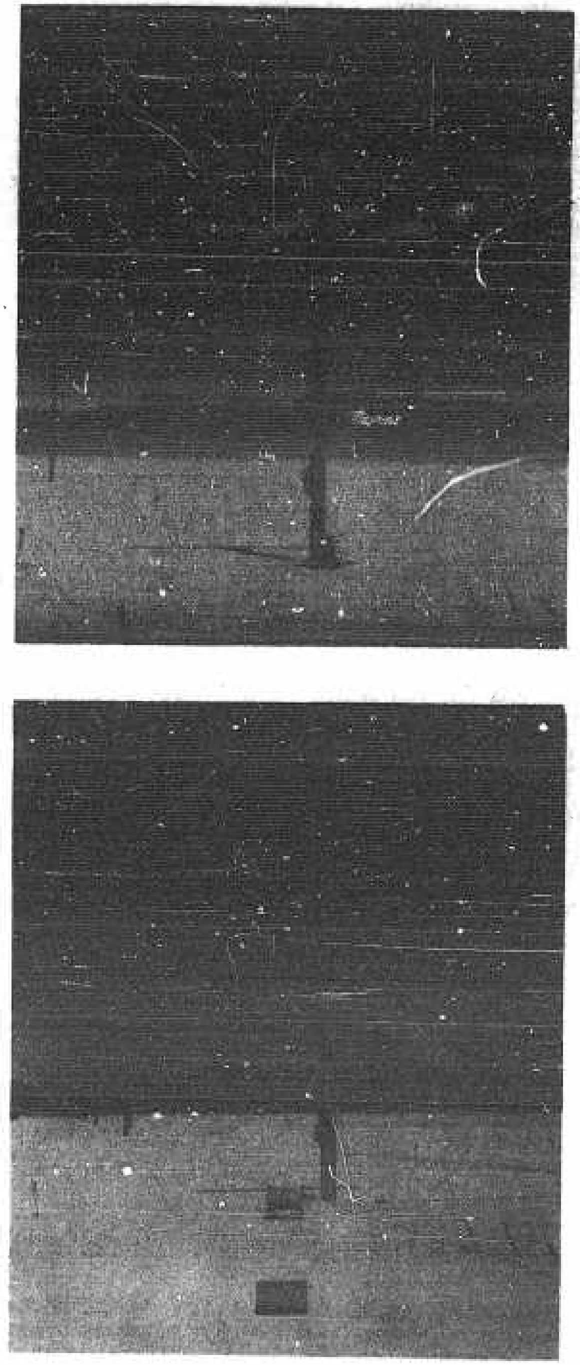
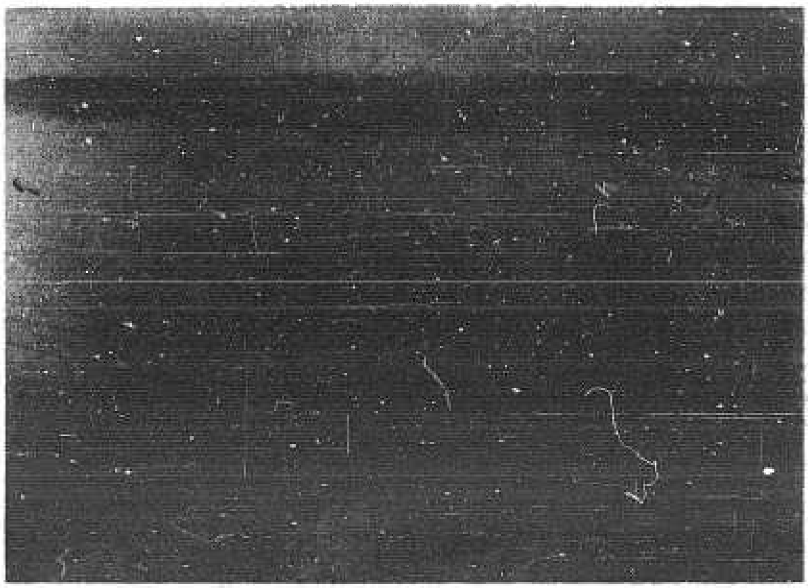


Fig. 3.50 Shot 9, Test Group 30, Transverse Pole Line, Poles A-1 through A-8, A-8 in Foreground. (Top-before, Bottom-after) 5425 ft, 25.5 cal, 5.6 psi.



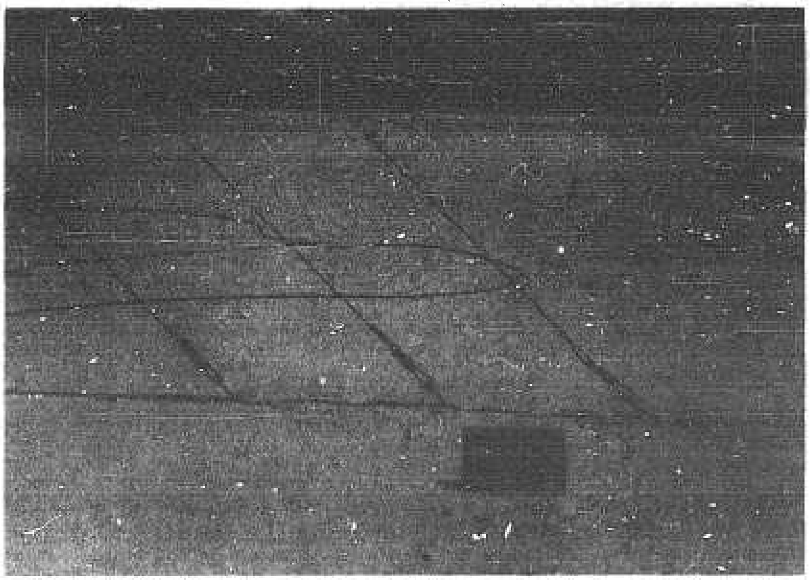


Fig. 3.51 Shot 9, Test Group 30, Transverse Pole Line, Triple Guys and Anchors on Pole A-8. (Top-before, Bottom-after) 5425 ft, 25.5 cal, 5.6 psi.

(12) JUNCTION BOXES AND TERMINAL STRIPS: These items received no substantial thermal or blast damage.

(13) EE-8 FIELD TELEPHONES: These telephones mounted on poles A-1 and A-8 were shielded from the thermal energy and received no thermal or blast damage.

c. PHOTOGRAPHS: Pre and post-Shot 9 photographs of this test group are shown in Figs. 3.43 through 3.51.

3.4 SURFACE WIRE AND CABLE – TEST GROUPS 2-2A; 25, 28 AND 31, SHOTS 9 AND 10 (FIG. 3.52)

3.4.1 Surface Wire and Cable – Test Group 2, Shots 9 and 10 (Fig. 3.52)

a. DESIGN: Test Group 2 consisted of a surface lay of one pair Wire WD-1/TT, one 5 pair rubber-covered cable CX-162/G, and one spiral four cable CX-1065/G, spaced 3 ft along the West side of the radial pole line extending to GZ and then South, terminating on a pole (Test Group 105) 170 ft from GZ.

b. RESULTS: Five Pair Rubber Covered Cable. This cable showed no apparent damage other than a slight blackening and roughening of the surface of the rubber jacket and all plastic dust caps at the cable connectors burned or melted from Test Group 105, 175 ft South of GZ (over 120 cal, over 21 psi), North by GZ to a point 4380 ft North (35 cal, 7.2 psi). Beyond this point there was no apparent damage except at a point opposite pole D-14 (6950 ft, 16 cal, 4.2 psi) where the cable lay across an anchor rod and there appeared to be a puncture in the sheath. All cable circuits were operable.

(1) SPIRAL FOUR CABLE: This cable showed some burning of the rubber jacket from Test Group 105, 175 ft South of GZ (over 120 cal, 21 psi). North by GZ to a point 2000 ft North, (82 cal, 12.6 psi). From 2000 ft North of GZ to a point 4640 ft North (32.5 cal, 6.8 psi) there was slight blackening and roughening of the rubber jacket. Beyond 4640 ft there was no apparent damage. All circuits were operable.

(2) FIELD WIRE WD-1/TT: From Test Group 105, 175 ft South of GZ (over 120 cal, over 21 psi), and North by GZ to a point 4380 ft (35 cal, 7.2 psi), the insulation was burned off severely damaging the wire. The insulation was fused and either exposed the conductors or became so brittle as to crack when the wire was bent by hand. It was observed that a short section of wire at approximately 2000 ft from GZ (82 cal, 12.6 psi) was covered with a layer of dust and suffered no apparent damage. It is significant to bear this observation in mind when considering the results of burying wire and cable 6 in. and 18 in.; between 4380 and 6050 ft (35-22 cal, 7.2 psi), the wire was damaged only where tied to ground stakes. At these points the sharp corners of the stakes cut sufficiently into the insulation as to expose the conductors. Beyond 6050 ft the wire received negligible damage.

c. PHOTOGRAPHS: Pre- and post-Shots 9 and 10. Photographs of this Test Group are combined with those for Test Groups 2A and shown in Fig. 3.52.

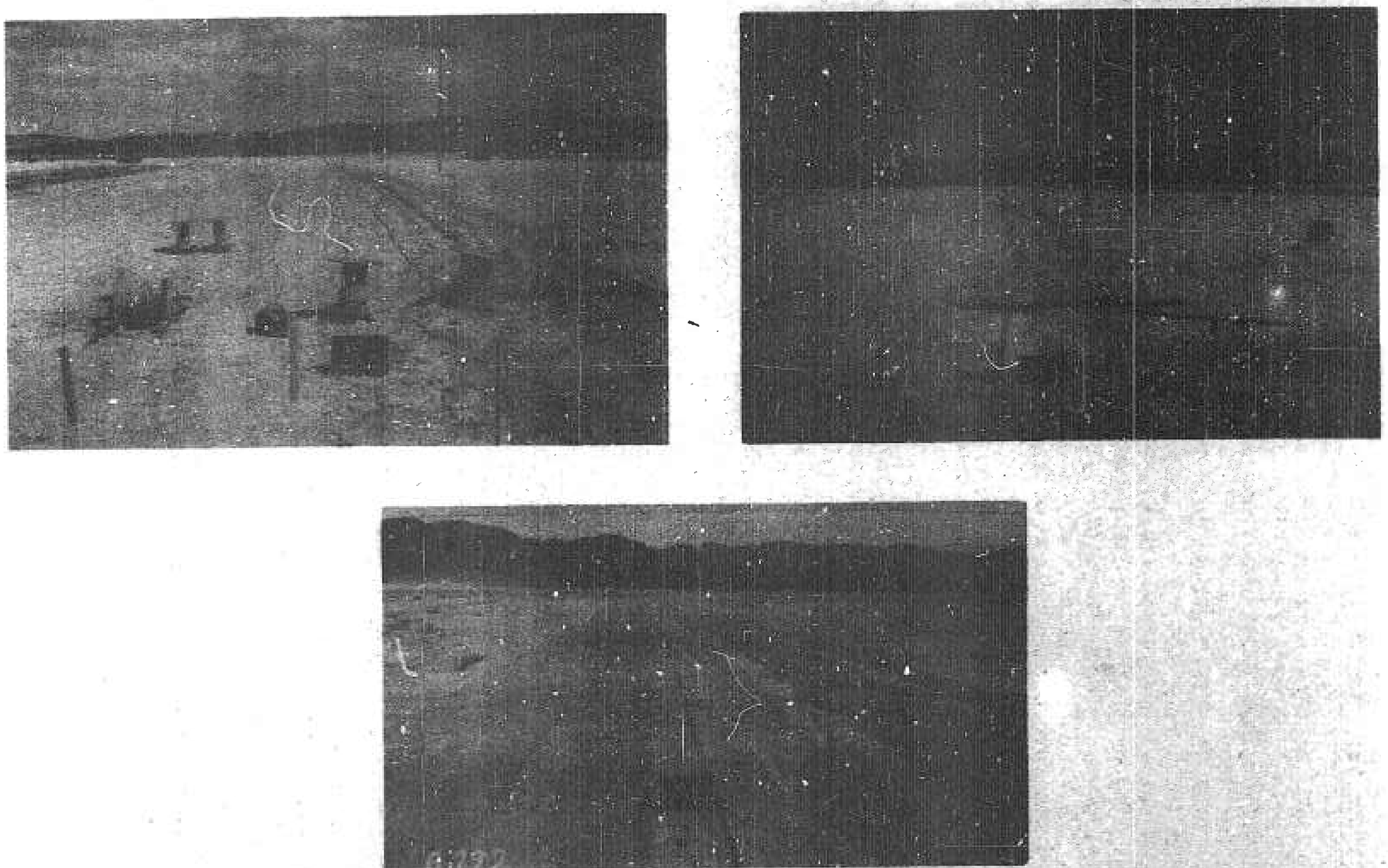


Fig. 3.52 Shots 9 and 10, Test Groups 2 and 2A, Surface Laid Wire and Cable. (Top left—before 9, Top right—after 9, Bottom—after 10) In Top View Cable Reels in Readiness to Lay along Ground Zero Just Prior to Shot 9. In Bottom View Photo Taken 2100 ft North Looking Toward Ground Zero. Shot 9, 1250 ft, 113 cal, 16.6 psi. Shot 10, 2100 ft, over 65 cal, 7.5 psi (At 2100 ft)

3.4.2 Surface Wire and Cable — Test Group 2A, Shot 10 (Fig. 3.52)

a. DESIGN: The surface wire and cable lays along the 1-1/2 mile radial pole line were rehabilitated and used in Shot 10 (Test Group 2A). The surface lays along the transverse pole line were not rehabilitated for Shot 10.

b. RESULTS: The surface laid wire and cable was severely damaged from Test Group 105, 800 ft South of GZ (over 60 cal, 5.0 psi). The wire and cable were intermittently broken, fused, melted, and snarled up. Beyond this point damage was negligible. A damage summary of this test group is shown in Table 3.6.

c. PHOTOGRAPHS: Pre- and post-Shots 9 and 10. Photographs of this Test Group have been combined with those of Test Group 2 and are shown in Fig. 3.52.

3.4.3 Surface Wire and Cable — Test Group 25, Shot 9 (Fig. 3.53)

a. DESIGN: Test Group 25, 28, and 31 consisted of surface lays of five pair rubber-covered cable CX-162/G, spiral four cable CX-1065/G and field wire WD-1/TT, spaced 3 ft apart and placed parallel to the transverse pole lines at 3425, 4450, and 5425 ft from GZ.

b. RESULTS: The five pair rubber-covered cable and the spiral four cable received no thermal or blast damage. The WD-1/TT field wire received severe thermal and blast damage (3400 ft, 50.0 cal, 9.6 psi).

c. PHOTOGRAPHS: Pre- and post-Shot 9. Photographs of this test group are shown in Figs. 3.53 through 3.56.

3.4.4 Surface Wire and Cable — Test Group 28, Shot 9 (Fig. 3.55)

a. DESIGN: The design of this test group was similar to that of Test Groups 25 and 31.

b. RESULTS: The five pair rubber covered cable and the spiral four cable received no thermal or blast damage. The WD-1/TT field wire received severe blast and thermal damage (4425 ft, 35 cal, 7.0 psi).

c. PHOTOGRAPHS: Pre- and post-Shot 9. Photographs of this test group are shown in Fig. 3.55.

3.4.5 Surface Wire and Cable-Test Group 31, Shot 9 (Fig. 3.56)

a. DESIGN: The design of this test group was similar to those of Test Groups 25 and 28.

b. RESULTS: The five pair rubber covered cable and the spiral four cable received no thermal or blast damage. The WD-1/TT field wire received moderate thermal damage and severe blast damage (5400 ft, 25.5 cal, 5.6 psi).

c. PHOTOGRAPHS: Pre- and post-Shot 9. Photographs of this test group are shown in Fig. 3.56.

3.5 UNDERGROUND WIRE AND CABLE — TEST GROUPS 3 AND 3A, SHOTS 9 AND 10 (FIG. 3.57)

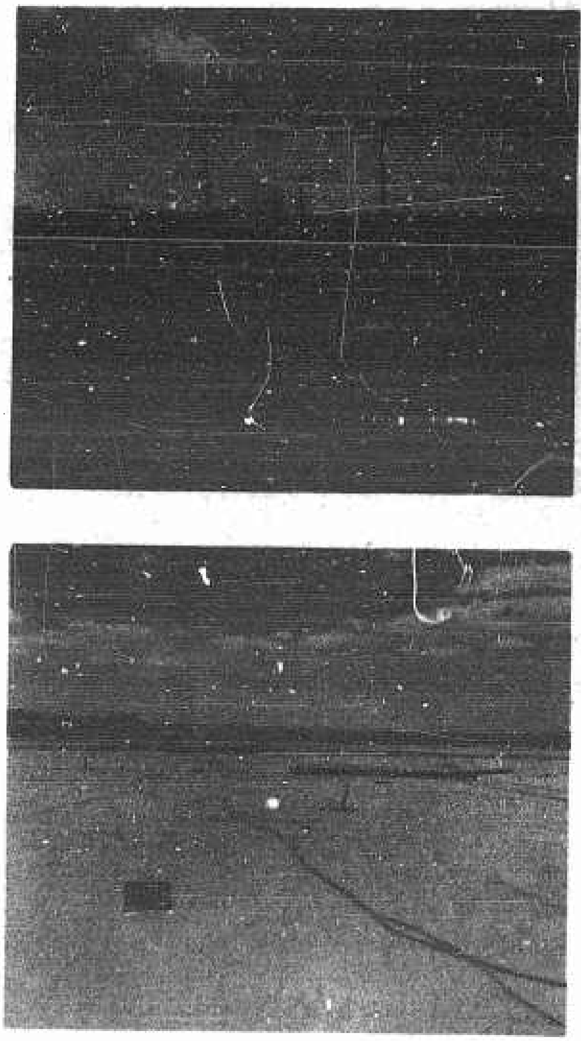


Fig. 3.53 Shot 9, Test Group 25, Surface Laid Wire and Cable Along Transverse Pole Line. Photos Taken from Center of Lays Looking West. (Top-before, Bottom-after) 3400 ft, 50 cal, 9.6 psi.

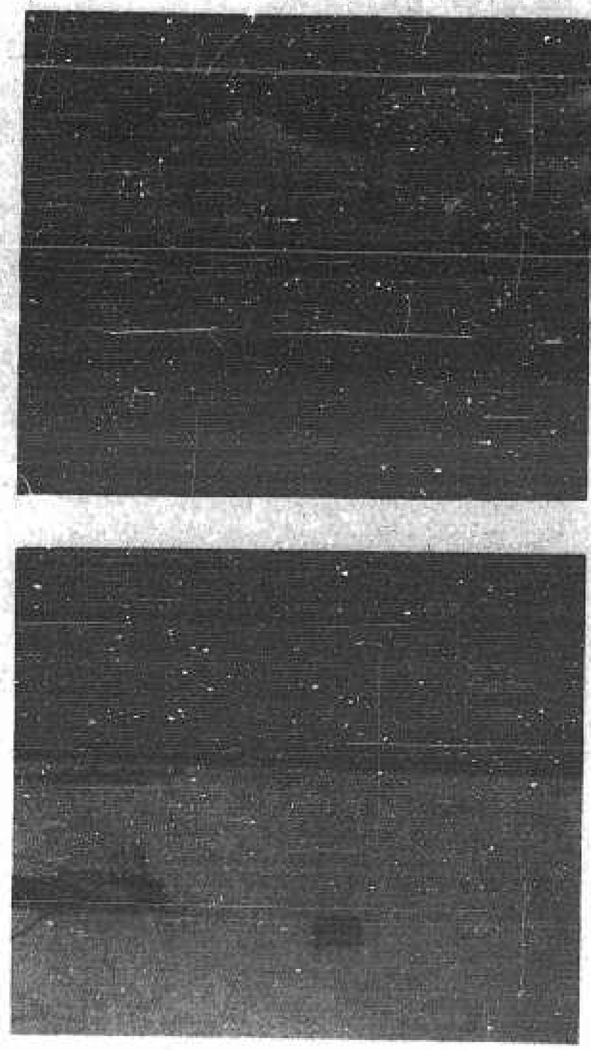


Fig. 3.54 Shot 9, Test Group 25, Surface Laid Wire and Cable Along Transverse Pole Line. Photos Taken from Center of Lays Looking East. (Top-before, Bottom-after) 3400 ft, 50 cal, 9.6 psi.

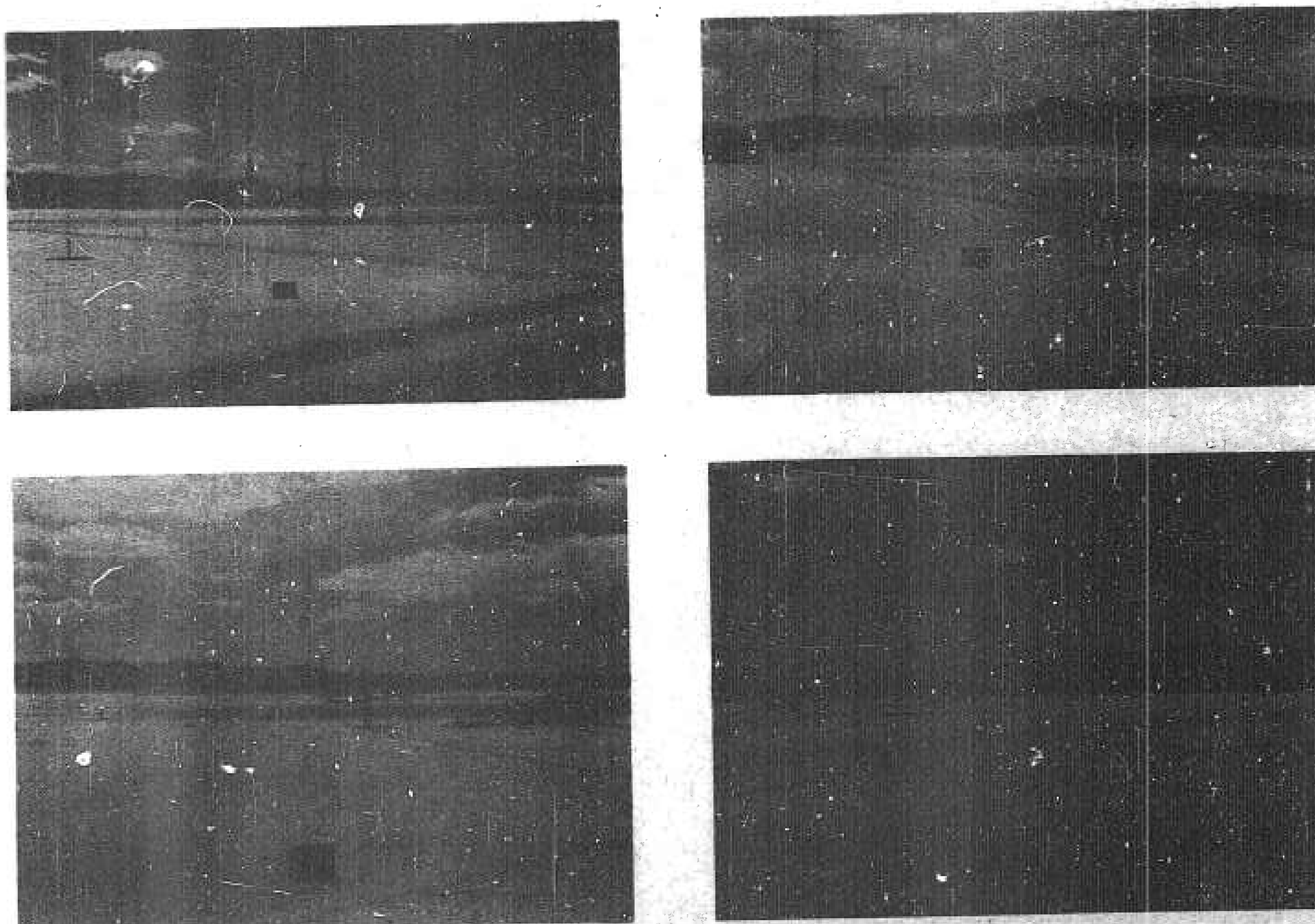


Fig. 3.55 Shot 9, Test Group 28, Surface Laid Wire and Cable along Transverse Pole Line. Photos Taken from Center of Lays Facing West. (Top left-before, Bottom left-after) Photos Taken from Center of Lays Facing East. (Top right-before, Bottom right-after) 4425 ft, 35 cal, 7 psi.

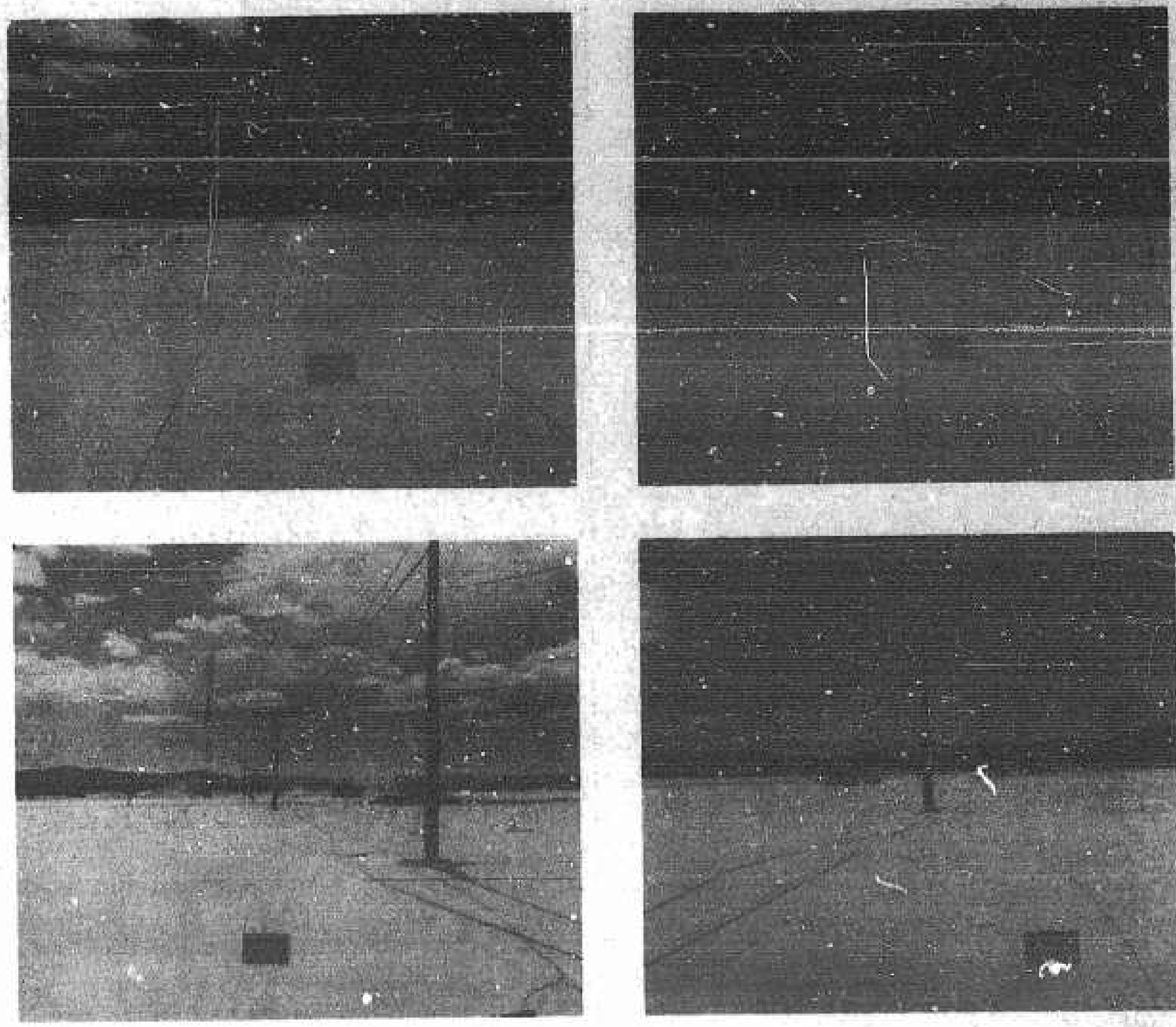


Fig. 3.56 Shot 9, Test Group 31, Surface Laid Wire and Cable Along Transverse Pole Line. Photos taken from Center of Lays Facing West. (Top-before, Bottom-after) Photos taken from Center of Lays Facing East. (Top right-before, Bottom right-after) 5400 ft, 25.5 cal, 5.6 psi.

TABLE 3.6 - Damage Summary

Surface Wire and Cable - Test Group 2A (Shot 10)

Test Group or Pole No.	Ft from GZ	cal	psi	Thermal Damage	Blast Damage	Remarks
	S-South N-North					
5 Pair Rubber Covered Cable						
105A to D-36	800S to 3000N	over 60	over 90	S	S	Cable intermittently evaporated fused and melted. Cable intermittently broken and snarled.
		43	5.0	S	S	
D-35	3000	43	5.0	N	N	
D-1	8350	5.0	1.0	N	N	Negligible thermal damage. No short circuits or opens.
Spiral Four Cable						
105A	800S	over 60	over 90	S	S	Cable intermittently evaporated fused and melted.
D-36	3000N	43	5.0	S	S	Cable intermittently broken and snarled.
D-36	3000	43	5.0	N	N	Negligible thermal damage.
D-1	8350	5.0	1	N	N	No short circuits or opens.
Wire WD-1/TT						
105A	800S	over 60	over 90	S	S	Wire evaporated intermittently fused and melted.
D-35	3140N	41	5.0	S	S	Wire intermittently broken and snarled.
D-35	3140N	41	5.0	N	L	Wire broken at mid-span.
D-34	3300N	37.5	5.0	N	L	
D-34	3300N	37.5	5.0	N	N	Negligible.
D-1	8350	5.0	1.0	N	N	

3.5.1 Underground Wire and Cable - Test Group 3, Shot 9 (Fig. 3.57)

a. DESIGN: Underground lays consisting of one pair wire WD-1/TT, one 5 pair rubber-covered cable CX-162/G, one spiral four cable CX-1065G, and one 26 pair lead-covered cable spaced 3 ft apart were buried at a depth of 6 in. below the surface using cable plow LC-61. These underground lays were duplicated at a depth of 18 in. below the surface. These lays started at terminal strips on pole D-37 (3500 ft from GZ) on the radial pole line and followed the same route as the surface lays terminating on terminal strips on a pole (Test Group 105) 175 ft South of GZ. It was recognized that it is not the normal practice to bury 26 pair lead covered cable, however, lead-armored cable was not available and the lead covered cable was used as a substitute.

b. RESULTS: The underground wire and cable, 26 pair lead-covered cable, five pair rubber covered cable, spiral four cable and WD-1/TT field wire, all buried at 6 in. and duplicated at 18 in., received no thermal or blast damage. All circuits were operable. The terminal strip TM-184 at which these circuits were all terminated on riser pole D-37 (3500 ft, 49 cal, 9.4 psi) received no thermal or blast damage. The top of the terminal JB11 at GZ and of these buried wires and cables was melted (175 ft, over 120 cal, over 21 psi). All circuits were operable; however, the lead covered riser cable above the ground showed evidence of the lead being melted and the sheath was broken in one place. The WD-1/TT field wire and jumper wire coming from underground and going up the riser pole (Test Group 105) received severe thermal damage. The 5 pair rubber covered cable and the spiral four cable coming from underground and terminating on cable reels at the base of the pole (Test Group 105) received no thermal or blast damage.

c. PHOTOGRAPHS: Pre- and post-Shots 9 and 10. Photographs of this test group have been combined with those of Test Group 3A and are shown in Fig. 3.57.

3.5.2 Underground Wire and Cable - Test Group 3A, Shot 10 (Fig. 3.57)

a. DESIGN: The underground wire and cable at 6 in. and 18 in. along the 1-1/2 mile radial pole line in Shot 10 were identical to those used in Shot 9 (Test Group 3).

b. RESULTS: The underground portions of the wire and cable, 26 pair lead covered cable, five pair rubber covered cable, spiral four cable, and WD-1/TT field wire all buried at 8 in. and duplicated at 18 in., received no thermal or blast damage. Had not the terminal end of the wire and cable at Test Group 105A (800 ft South of GZ, over 60 cal, and over 90 psi) been severely damaged these circuits would have been operable. The pole (Test Group 105A), and all terminals and all wire and cable coming out of the ground at this point evaporated. There was negligible thermal and blast damage to the wire and cable coming out of the ground at pole D-37 (2900 ft, 47.5 cal, 5.0 psi). There was no significant damage to the terminal strip TM-184 at pole D-37.

c. PHOTOGRAPHS: Pre- and post-Shot 10. Photographs of this test group have been combined with those of Test Group 3 and are shown in Fig. 3.57.

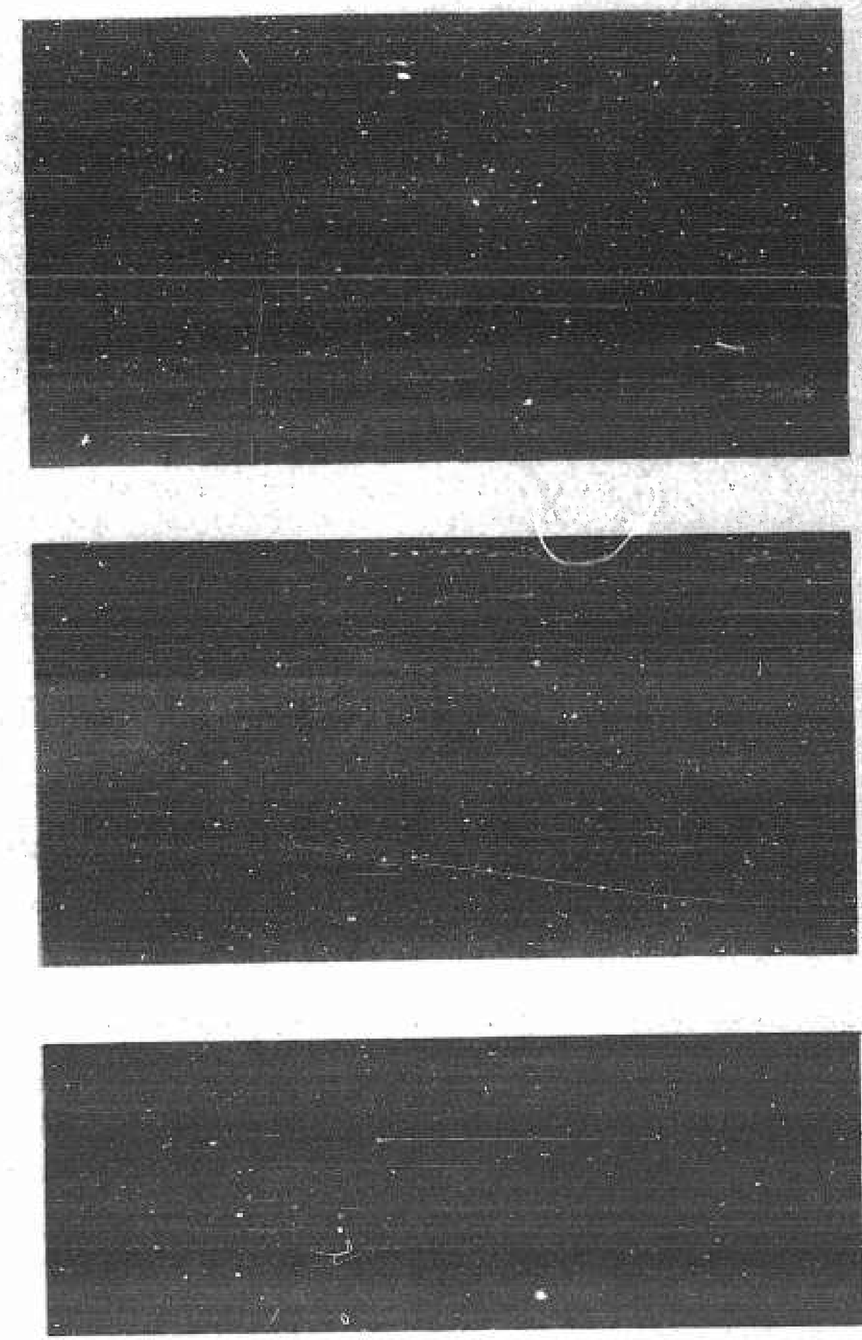


Fig. 3.57 Shots 9 and 10, Test Groups 3 and 3A. Underground Wire and Cable. Wire and Cable Lays Buried 6 in. and 18 in. cannot be seen. They parallel the Pole Line Directly under Surface Lays. These Photos Show Condition of Surface above the Lays. (Top-before 9, Center-after 9, Bottom-after 10) Shot 9 - 3050 ft N-175 ft S, 57.5 over 120 cal, 10.4 over 21 psi (At Surface). Shot 10 - 2425 ft N-800 ft S, over 65 cal, 6 over 90 psi (At Surface).

3.6 SEPARATE POLES — TEST GROUPS 4-9, 4A-9A, 83-85, 103-105, 103A-105A, SHOTS 9 AND 10

3.6.1 Separate Poles — Test Groups 4-9, Shot 9 (Figs. 3.58 - 3.63)

a. DESIGN: Test Groups 4 through 9, except Test Group 5, consisted of one 30 ft creosoted southern pine class 7 unguyed pole, one 30 ft creosoted southern pine class 7 fourway storm guyed pole, and one 45 ft creosoted southern pine class 3 unguyed pole at 1850, 2825, 3825, 4825, and 5800 ft from GZ. Test Group 5 consisted of a 30 ft creosoted southern pine class 7 fourway storm guyed pole located 2350 ft from GZ. The 30 ft poles were set 5-1/2 ft deep and the 45 ft poles were set 6 ft deep. No crossarms or hardware, other than the guys were mounted on these poles.

b. RESULTS: These test groups were blackened but were not damaged in Shot 9. The earth was retamped around the poles, the guy wires were tightened. The poles were used in Shot 10. A damage summary for these test groups is shown in Table 3.7.

c. PHOTOGRAPHS: Pre- and post-Shot 9. Photographs have been combined with those of Test Groups 4A-9A and are shown in Figs. 3.58 - 3.63.

3.6.2 Separate Poles — Test Groups 4A-9A, Shot 10 (Figs. 3.58 - 3.63)

a. DESIGN: Test Groups 4A-9A were identical to those of Test Groups 4-9. After Shot 9 these poles were retamped and used in Shot 10. The 30 ft pole in Test Group 8A (pole F-1) was removed between Shots 9 and 10. This group therefore contained only the 30 ft guyed and the 45 ft unguyed poles.

b. RESULTS: Test Groups 3A-6A were severely damaged. Test Group 7A received light blast damage. Test Groups 8A-9A received negligible damage in Shot 10. A damage summary for these test groups is shown in Table 3.8.

c. PHOTOGRAPHS: Pre- and post-Shot photographs of Test Groups 4A-9A have been combined with those of Test Groups 4-9 and are shown in Figs. 3.58-3.63.

3.6.3 Separate Poles — Test Groups 83-85, Shot 9 (Figs. 3.64 - 3.66)

a. DESIGN: Test Groups 83, 84, and 85 consisted of one each 30 ft creosoted southern pine class 7 pole installed at Medical Corps field hospitals located at 4125, 9000, and 15,000 ft from GZ. These poles installed by Project 3.20 personnel were used for electric power distribution wires. They also served as test groups for effects upon separate poles at these distances.

b. RESULTS: These poles received no significant damage in Shot 9.

c. PHOTOGRAPHS: Pre- and post-shot photographs of these test groups are shown in Figs. 3.64 - 3.66. There was no participation for these test groups in Shot 10.

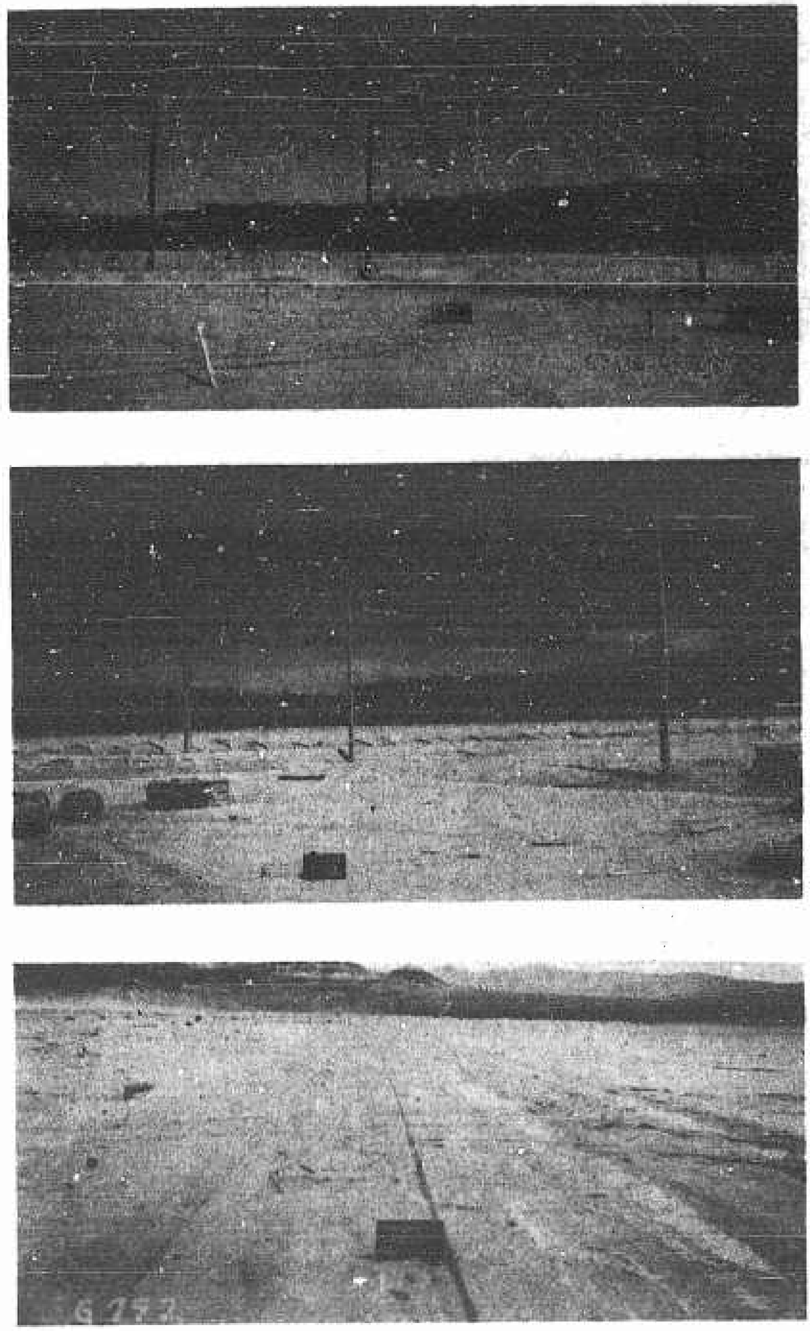


Fig. 3.58 Shots 9 and 10, Test Groups 4 and 4A, Separate Poles. (Top-before 9, Center-after 9, Bottom-after 10) (In Bottom View Note the Foxhole on Left Hand Side of Photo - Test Group 4A was about 1000 ft forward and 25 ft to the Left of this Foxhole. The Three Poles were Disintegrated in Shot 10) Shot 9 - 1850 ft, 85 cal, 13.2 psi. Shot 10 - 1120 ft, over 60 cal, 32 psi.

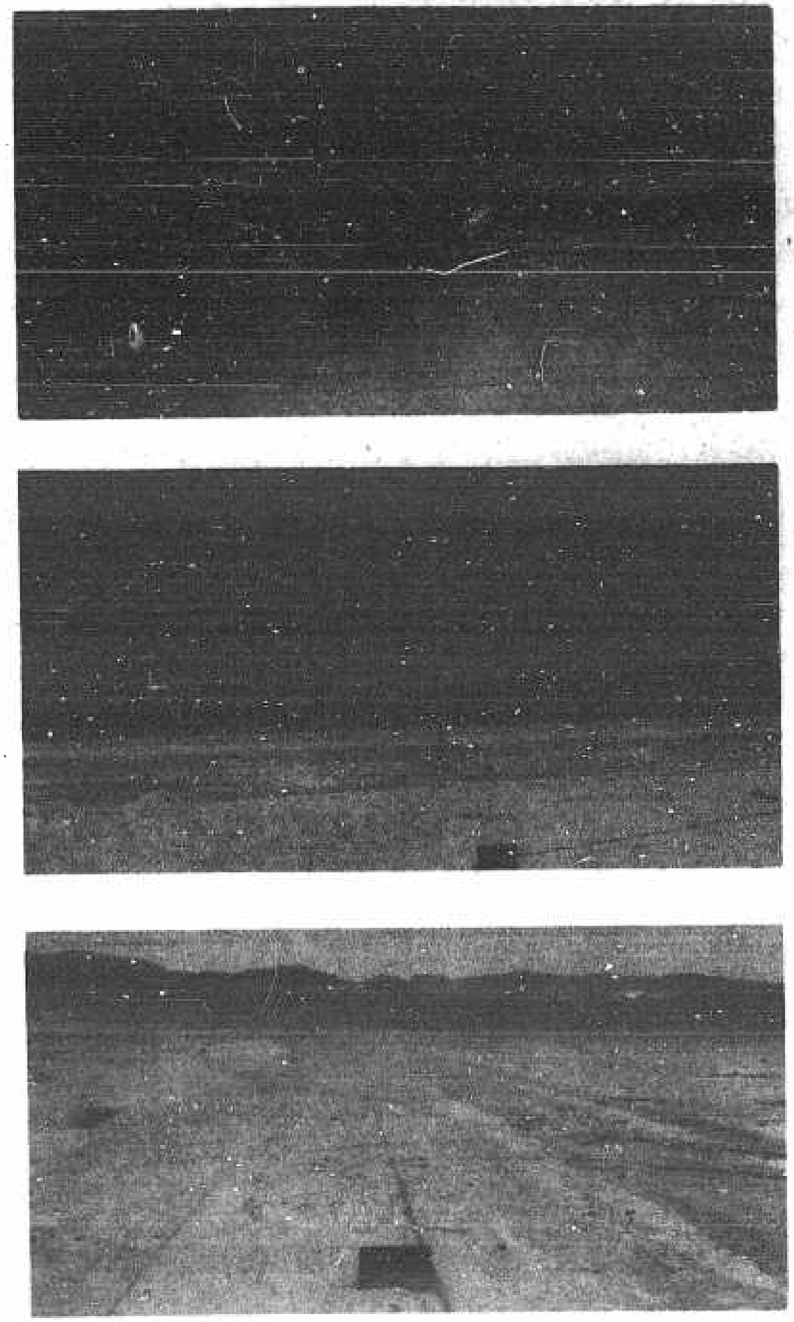


Fig. 3.59 Shots 9 and 10, Test Groups 5 and 5A, Separate Poles. (Top-before 9, Center-after 9, Bottom-after 10) (In Bottom View Note the Foxhole on Left Hand Side of Photo - Test Group 5A was Located about 500 ft forward and 50 ft to the Left of this Foxhole. The Pole was Disintegrated.)

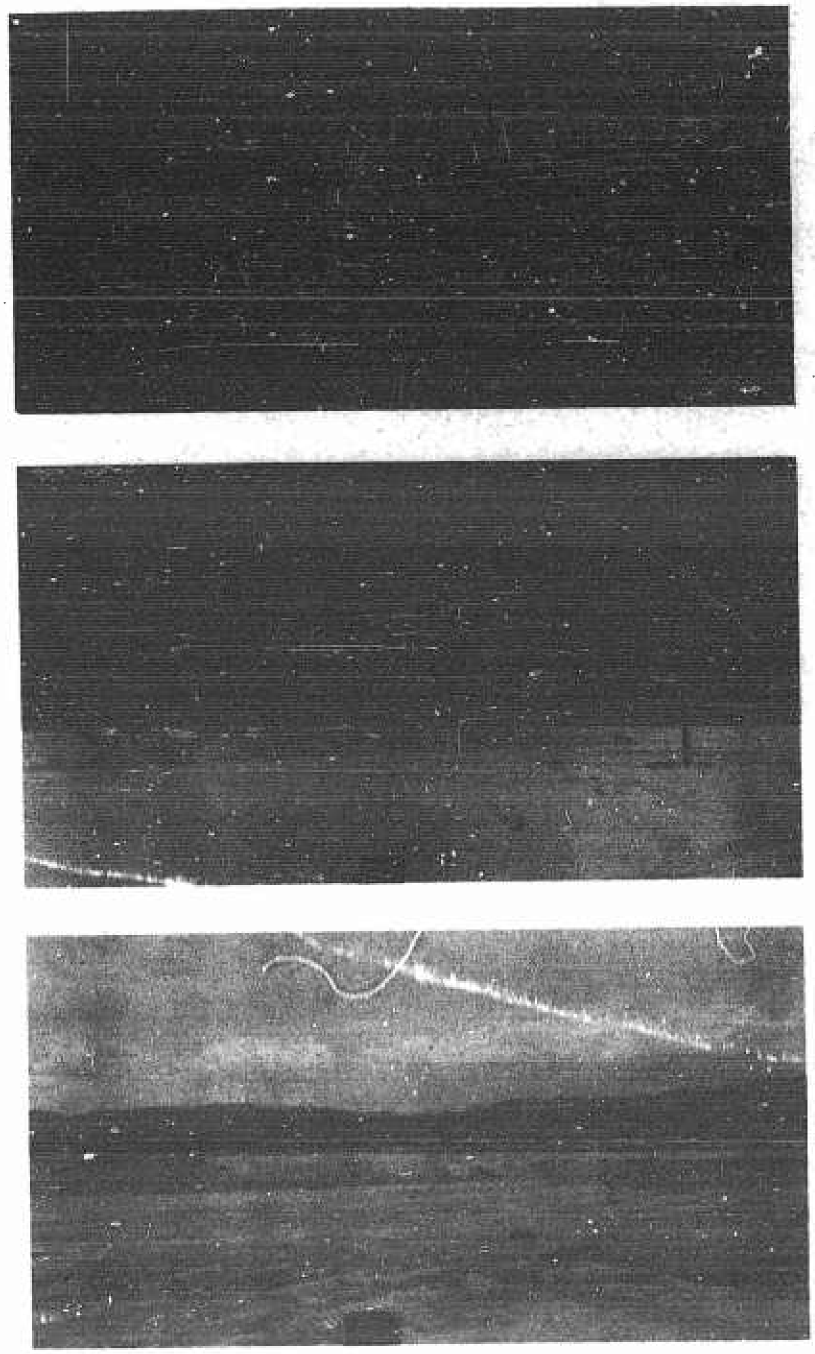


Fig. 3.60 Shots 9 and 10, Test Groups 6 and 6A, Separate Poles. (Top-before 9, Bottom-after 10) (In Bottom View the Splintered Stubs of the Three Poles can be Seen Diagonally Across the Photo from Right to Left) Shot 9 - 2825 ft, 61.5 cal, 10.8 psi. Shot 10 - 2125 ft, over 60 cal, 7 psi.

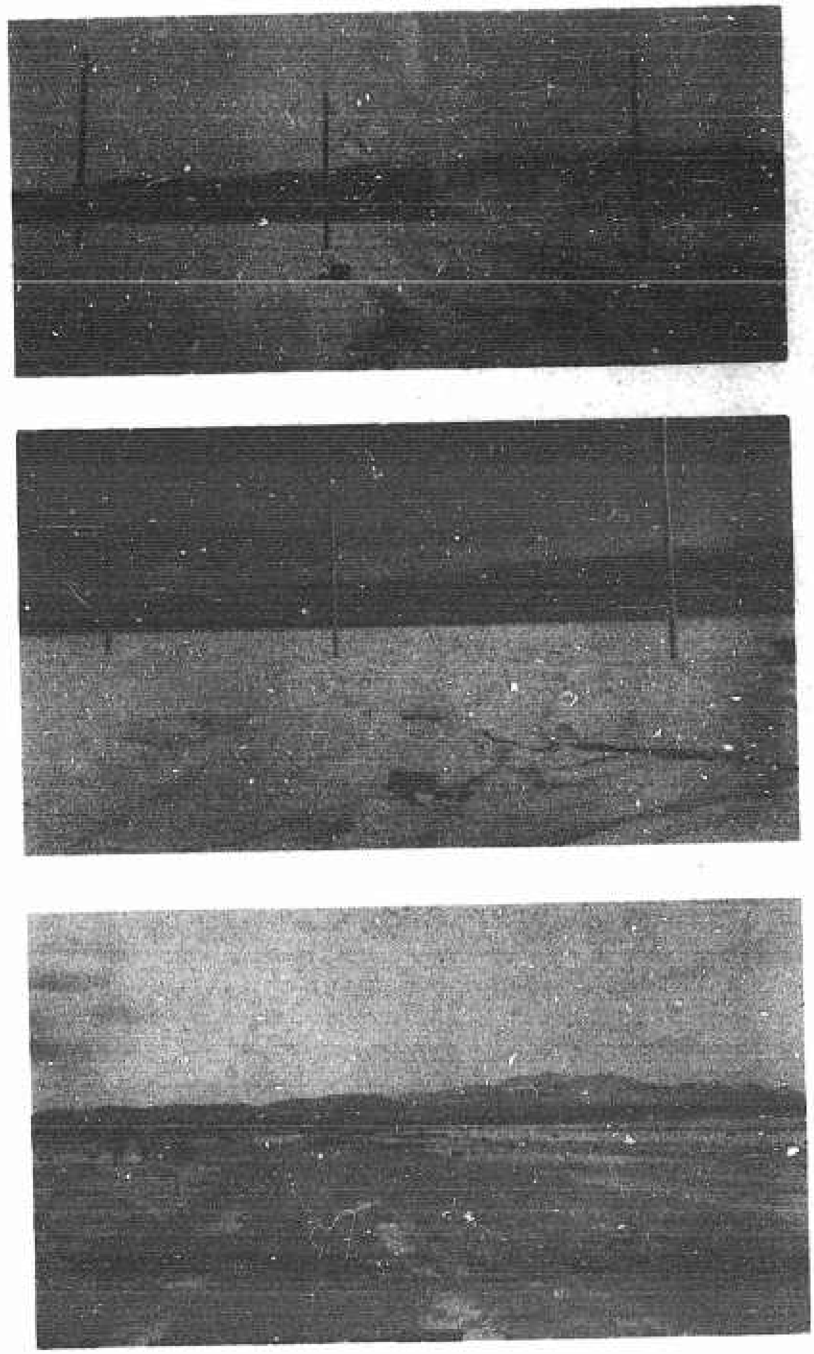


Fig. 3.61 Shots 9 and 10, Test Groups 7 and 7A, Separate Poles. (Top-before 9, Center-after 9, Bottom-after 10) (In Bottom View Test Group 7A, 3 Separate Poles can be seen to the Right of Pole D-36. Test Group 7A is the First of the Separate Poles which Remained Standing after Shot 10) Shot 9 - 3825 ft, 43.5 cal, 8.6 psi. Shot 10 - 3125 ft, 41 cal, 5 psi.

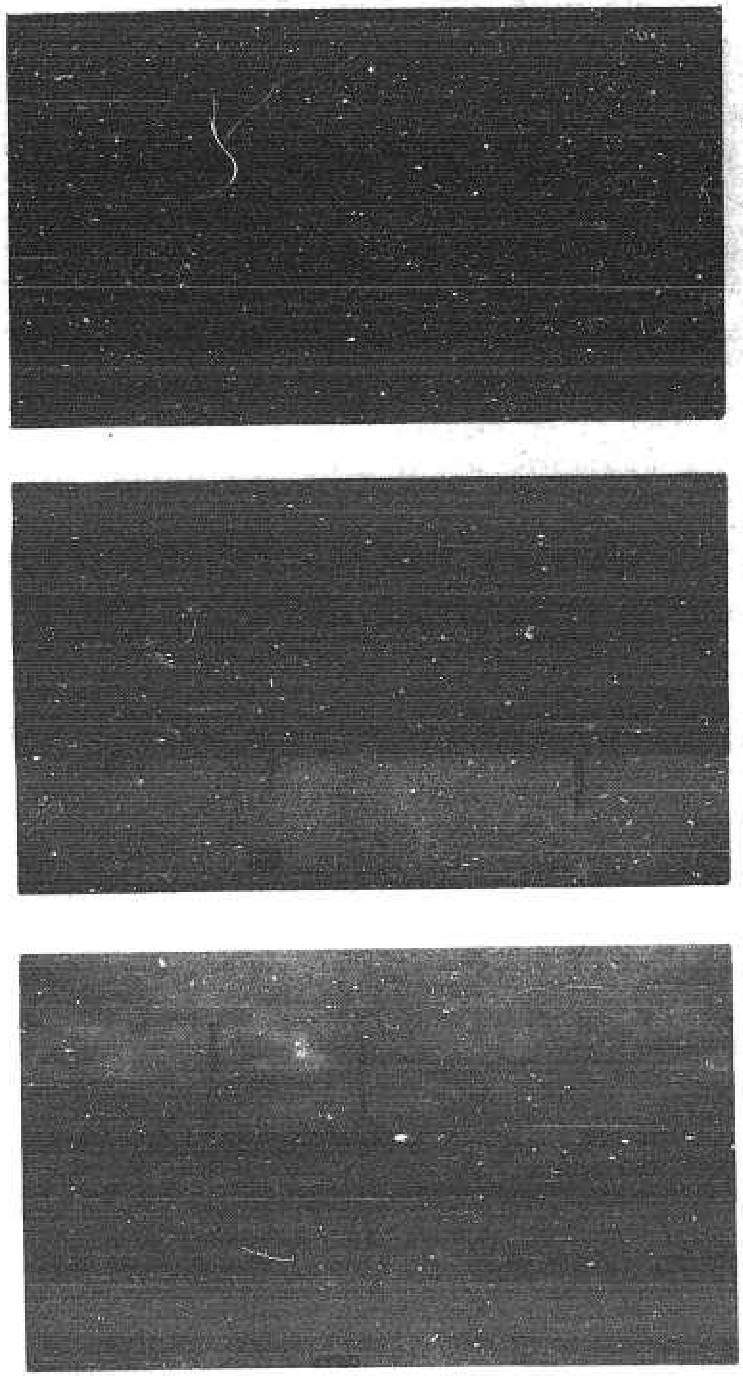


Fig. 3.62 Shots 9 and 10, Test Groups 8 and 8A, Separate Poles. (Top-before 9, Center-after 9, Bottom-after 10) (Pole on Bottom Right was Removed for other use prior to Shot 10.)
Shot 9 - 4875 ft, 30.5 cal, 6.2 psi.
Shot 10 - 4200 ft, 24 cal, 4 psi.

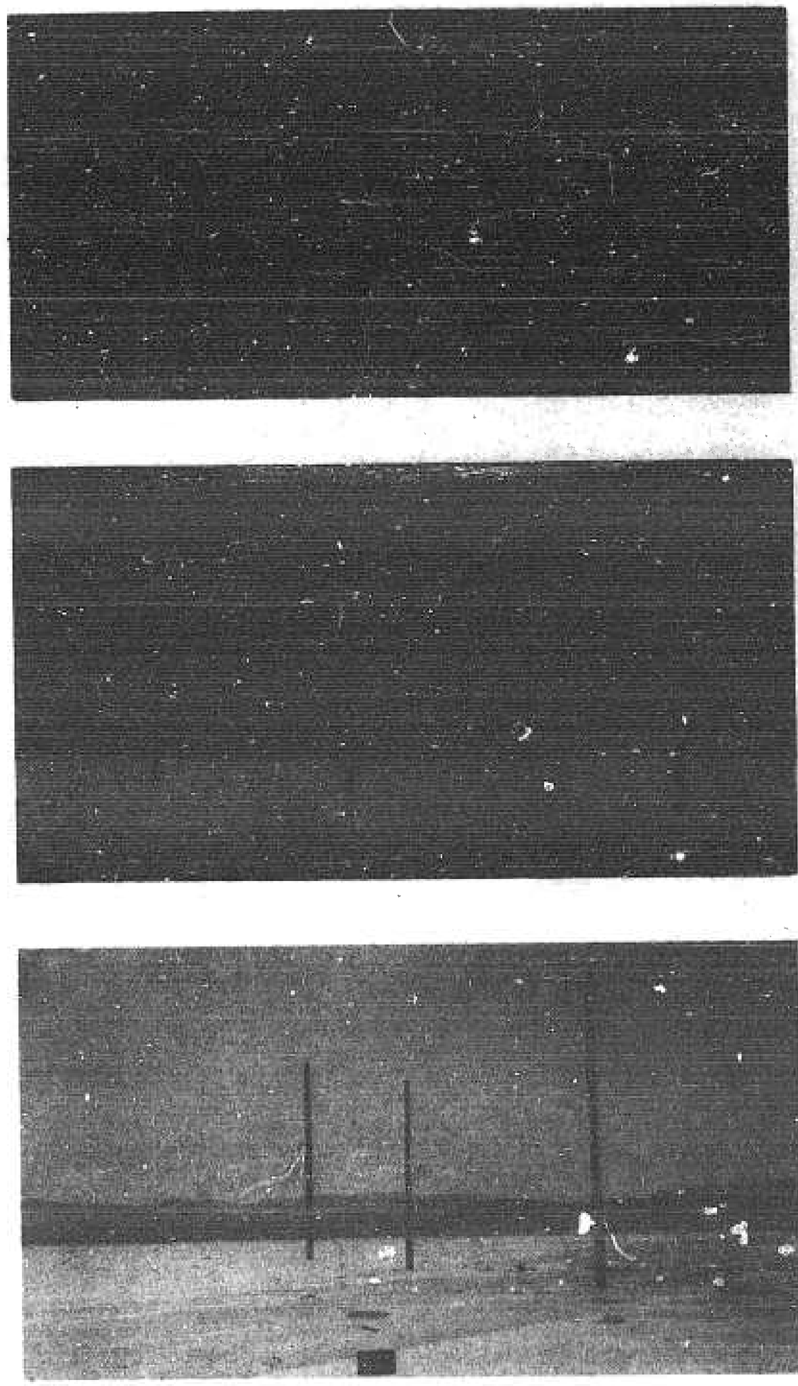


Fig. 3.63 Shots 9 and 10, Test Groups 9 and 9A, Separate Poles. (Top-before 9, Center-after 9, Bottom-after 10)
Shot 9 - 5800 ft, 23.5 cal, 5.2 psi.
Shot 10 - 5125 ft, 16 cal, 3 psi.

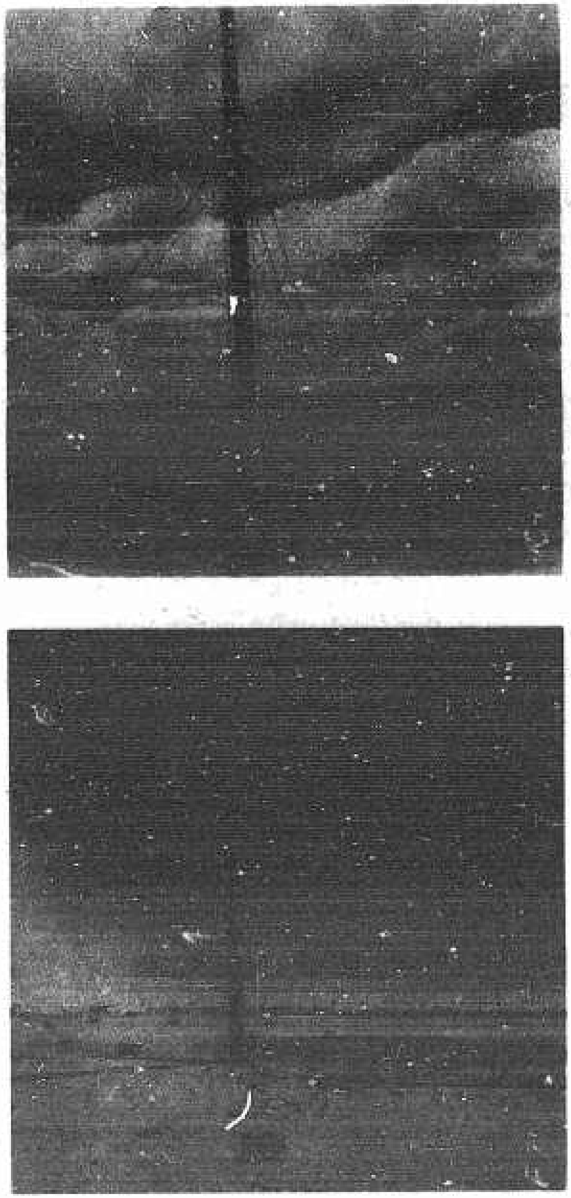


Fig. 3.64 Shot 9, Test Group 83. SigC Items in Med. C. Installations, Separate Pole. (Top-before, Bottom-after) 4125 ft, 39.5 cal, 8 psi.

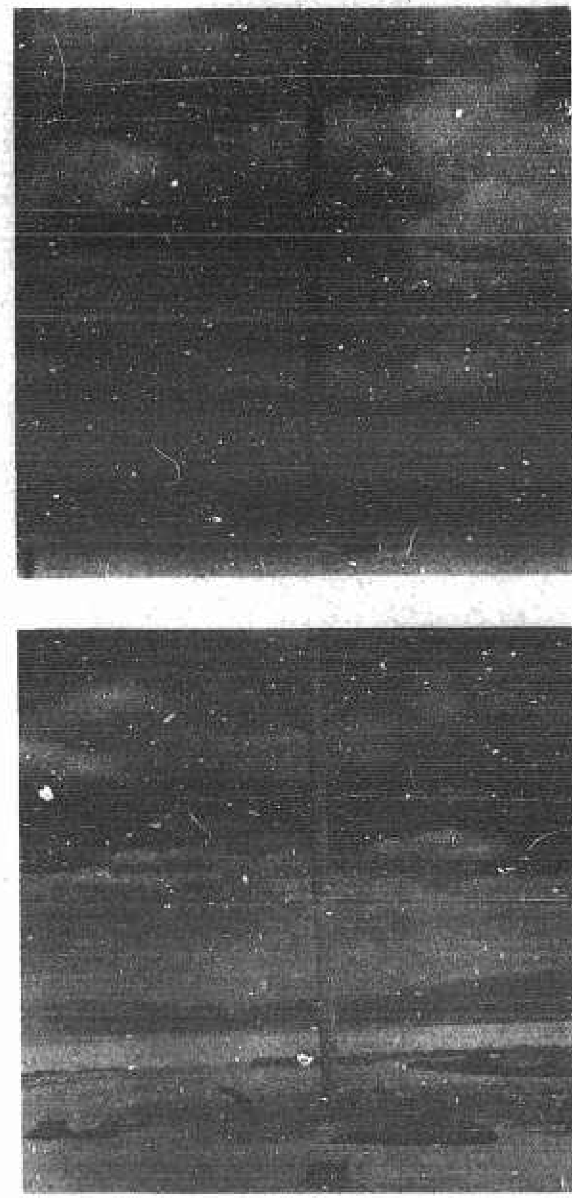


Fig. 3.65 Shot 9, Test Group 84. SigC Items in Med.C. Installations, Separate Pole (Top-before, Bottom-after) 9000 ft, 8.5 cal, 3 psi.

NOTE: Wire and Attachments Removed from Pole after Shot 9 but Prior to Taking the Bottom Photo. They were not damaged.

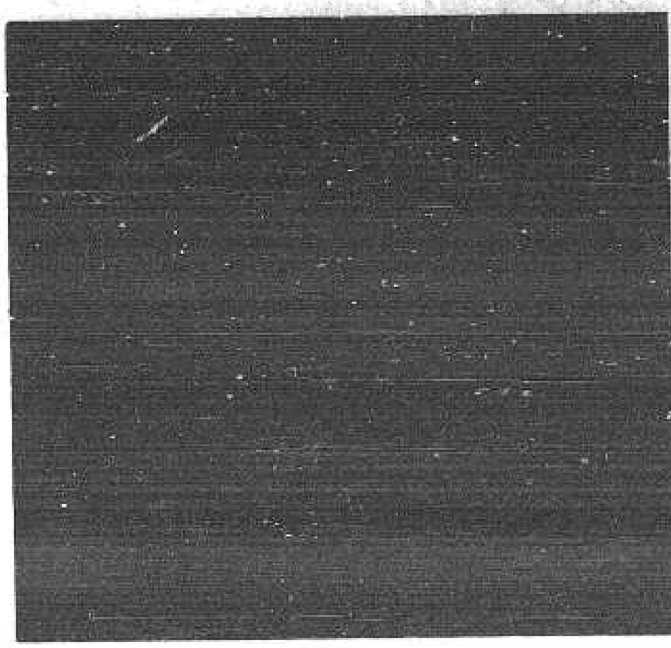


Fig. 3.66 Shot 9, Test Group 85, SigC Items in Mod.C Installations, Separate Pole. (Top-before, Bottom-after) 1500 ft, less than 1 cal, less than 1 psi.
NOTE: Wire and Attachments Removed from Pole after Shot 9 but prior to taking this photo. They were not damaged.

TABLE 3.7 — Damage Summary

Separate Poles — Test Groups 4-9, Shot 9

Test Group No.	Ft from GZ	cal	psi	Thermal Damage	Blast Damage	Remarks
4	1850	85	13.2	N	N	J-2 slack, need tightening. Poles loose.
5	2350	72	11.4	N	N	Slight scorching. Guys slack, pole loose.
6	2825	61.5	10.8	N	N	Slight scorching. Poles loose, back guy pole G-2 slack.
7	3825	43.5	8.6	N	N	Needed tightening, poles loose.
8	4875	30.5	6.2	N	N	Slight scorching, poles loose.
9	5800	23.5	5.2	N	N	Slight scorching, poles loose.

TABLE 3.8 — Damage Summary

Separate Poles — Test Groups 4A-9A, Shot 10

Test Group No.	Ft from GZ	cal	psi	Thermal Damage	Blast Damage	Remarks
4A	1125	over 60	32	S	S	Poles disintegrated and scattered about area.
5A	1650	over 60	11	S	S	Poles disintegrated and scattered about area.
6A	2125	over 60	7	S	S	Poles broken and splintered and scattered about the area.
7A	3125	41	5	L	L	Poles slightly charred, guys slack pole G-2, poles loose.
8A	4200	24	4	N	N	Slight scorching, guys loose pole F-2, poles loose.
9A	5125	16	3	N	N	Slight scorching, guys loose, poles loose.

3.6.4 Separate Poles — Test Groups 103 - 105, Shot 9 (Figs. 3.67-3.69)

a. DESIGN: Test Groups 103 through 105 consisted of 3 separate 30 ft creosoted southern pine 30 ft, class 7 poles set to a depth of 5-1/2 ft at distances of 1150, 850, and 175 ft from GZ. Test Group 105 also served as the terminating pole for the surface and underground wires and cables (Test Groups 2 and 3).

b. RESULTS: None of the separate poles received any significant damage in Shot 9. A damage summary of these test groups is shown in Table 3.9.

TABLE 3.9 - Damage Summary

Separate Poles - Test Groups 103-105 (Shot 9)

Test Group No.	Ft from GZ	cal	psi	Thermal Damage	Blast Damage	Remarks
105	175S	over 120	over 21	N	N	Top of pole charred to about 1/64 in. thickness.
104	850N	over 120	over 21	N	N	Very little thermal damage on sides. No other damage. Slight scorching.
103	1150N	120	17.8	N	N	Slight scorching on all 3 poles. No other damage.

c. PHOTOGRAPHS: Pre- and post-Shots 9 and 10 photographs of these test groups have been combined with Test Groups 103A - 105A and are shown in Figs. 3.67 - 3.69.

3.6.5 Separate Poles — Test Groups 103A - 105A, Shot 10 (Figs. 3.67 - 3.69)

a. DESIGN: Test Groups 103A through 105A were the same poles used in Shot 9; the earth was retamped around the poles prior to Shot 10.

b. RESULTS: All three of the separate poles were splintered and scattered about the area. A damage summary of these test groups is shown in Table 3.10.

c. PHOTOGRAPHS: Pre- and post-Shots 9 and 10. Photographs of these groups have been combined with Test Groups 103 - 105 and are shown in Figs. 3.67 - 3.69.

3.7 EXPOSURE BOARDS - TEST GROUPS 10 - 23, 98 - 99, AND 10A - 13A, SHOTS 9 AND 10

3.7.1 Exposure Boards — Test Groups 10 - 23, 98 - 99, Shot 9 (Figs. 3.70 - 3.85)

a. DESIGN: These test groups consisted of eight pairs of aluminum exposure (display) boards placed at 1000 ft intervals along the east side of the radial pole line from 1825 ft to 8800 ft from GZ. In

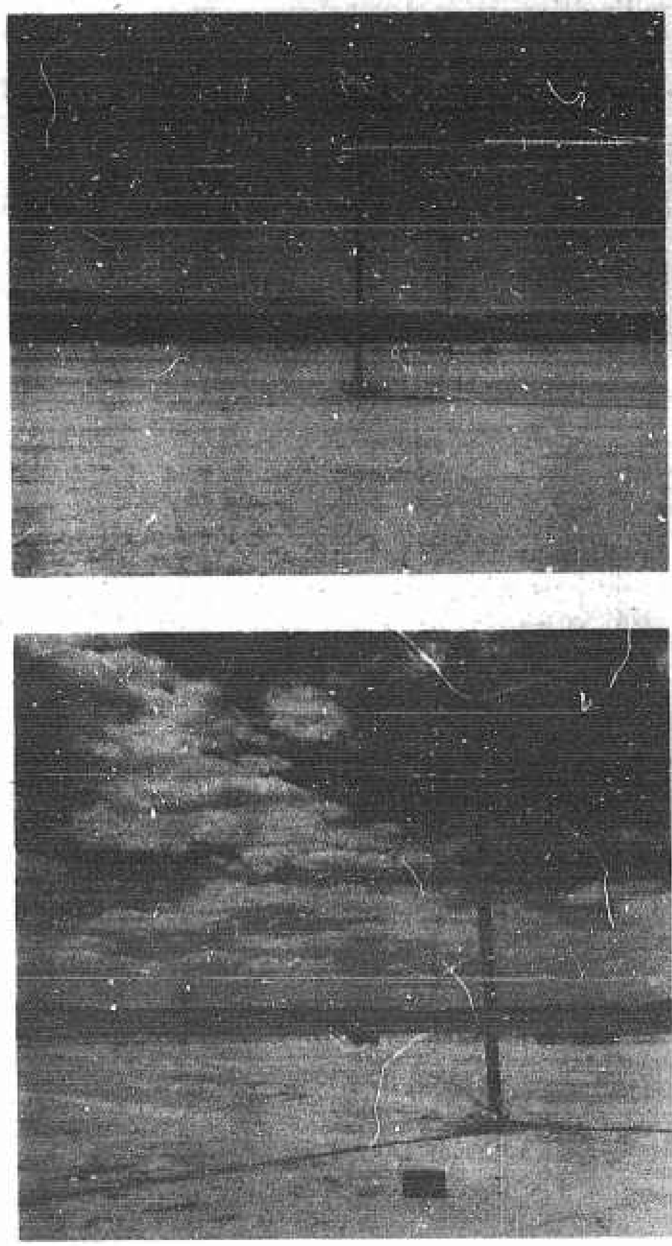


Fig. 3.67 Shots 9 and 10, Test Groups 103 and 103A, Seperate Pole.
(Top—before 9, Center—after 9, Bottom—after 10)
Shot 9 - 1150 ft, 120 cal, 17.8 psi.
Shot 10 - 500 ft, over 60 cal, over 115 psi.

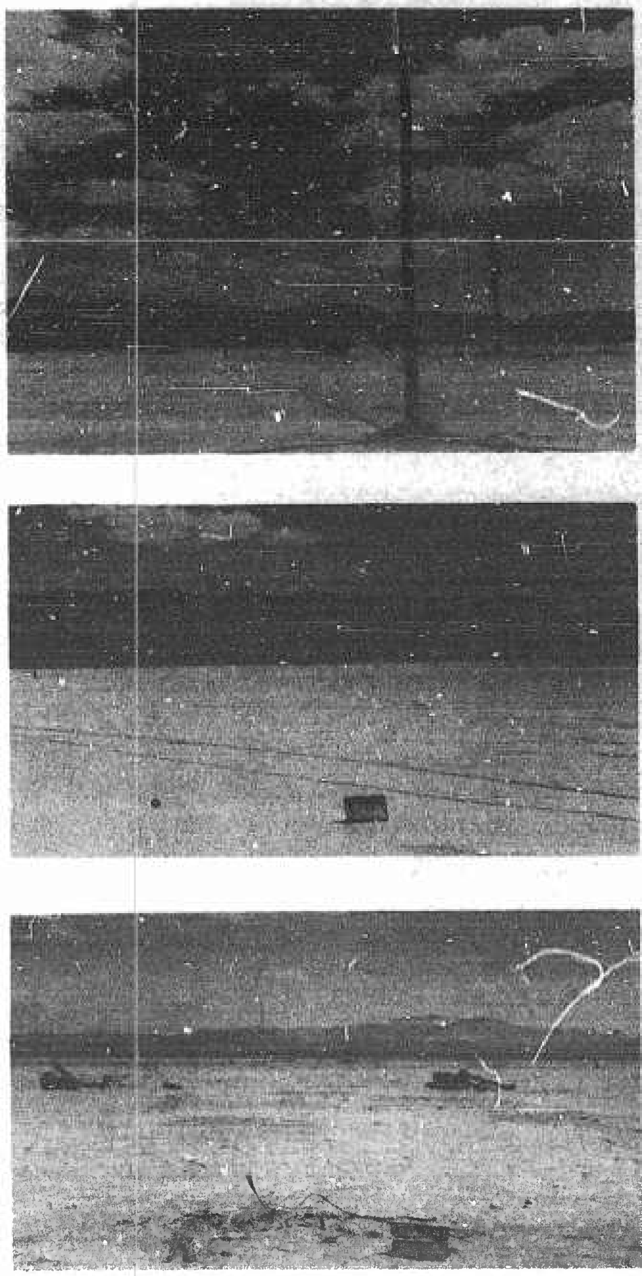


Fig. 3.68 Shots 9 and 10, Test Groups 104 and 104A, Separate Pole. (Top-before 9, Center-after 9, Bottom-after 10) (In Center View Test Group 104 is the First Pole from Left to Right in the Background. In Bottom View Test Group 104A was 900 ft forward of Test Group 105A, about where the Pole Stub can be seen in Upper Righthand Side of Bottom Photo. Shot 9 - 850 ft, over 120 cal, over 21 psi. Shot 10 - 300 ft, over 60 cal, over 115 psi.

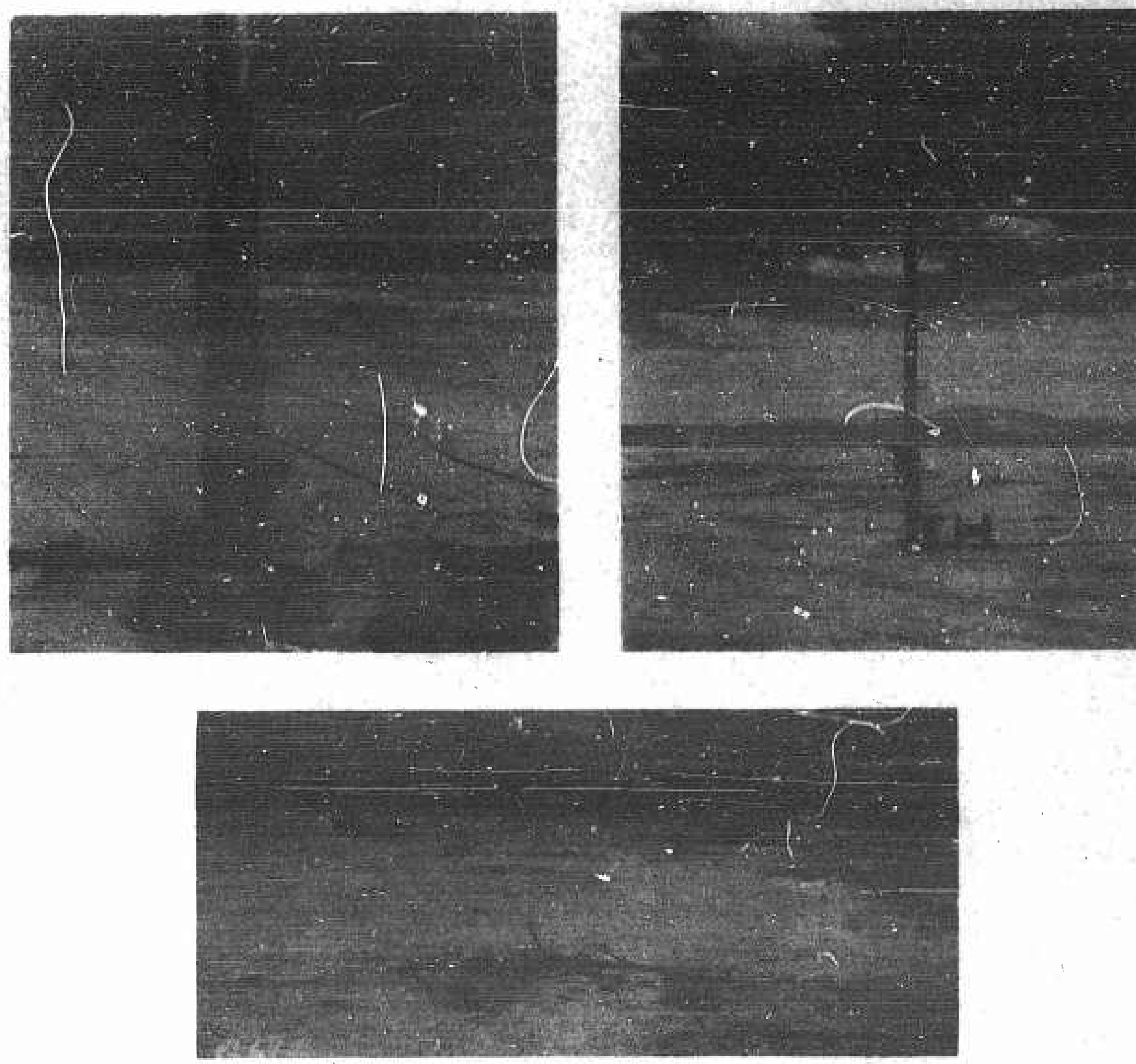


Fig. 3.69 Shots 9 and 10, Test Groups 105 and 105A, Separate Pole.
(Top-before 9, Right-after 9, Bottom-after 10)
Shot 9, 175 ft, over 120 cal, over 21 psi.
Shot 10 - 800 ft, over 60 cal, over 90 psi

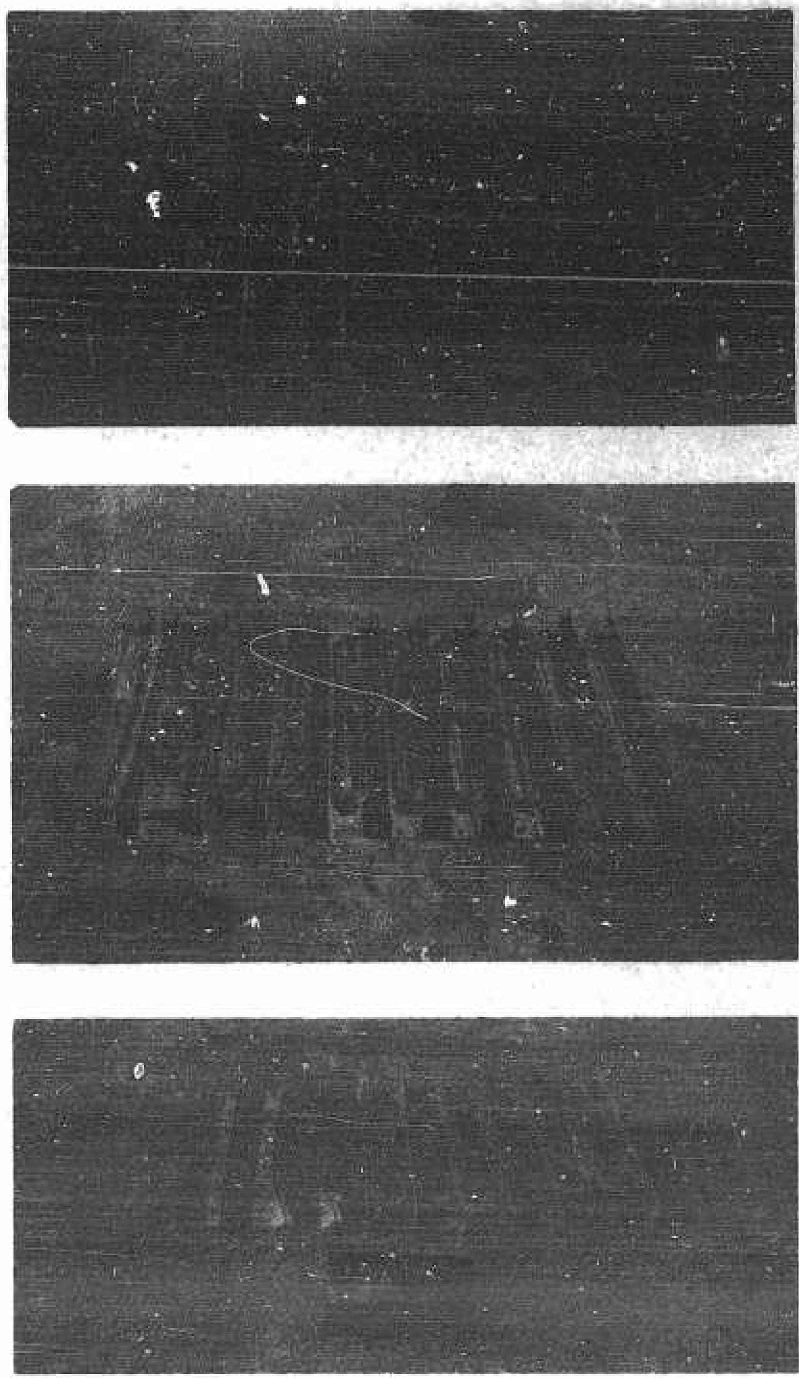


Fig. 3.70 Shots 9 and 10, Test Groups 10 and 10A, Exposure Boards. (Top-before 9, Center-after 9, Bottom-after 10) (A new Exposure Board was Positioned for Shot 10.) Shot 9 -
Shot 9 - 1825 ft, 88 cal, 13.2 psi.
Shot 10 - 1125 ft, over 60 cal, 32 psi.

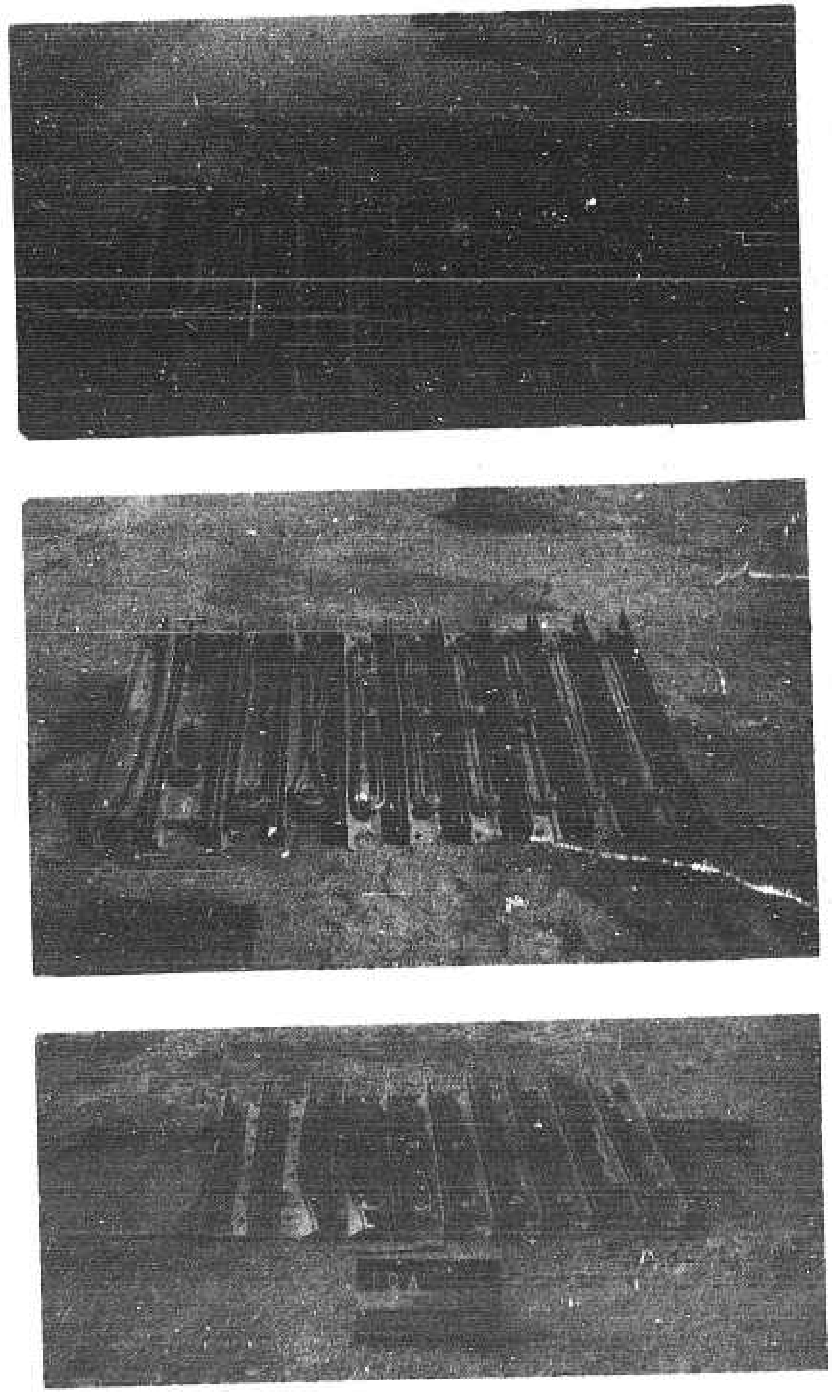


Fig. 3.70 Shots 9 and 10, Test Groups 10 and 10A, Exposure Boards. (Top-before 9, Center-after 9, Bottom-after 10) (A new Exposure Board was Positioned for Shot 10.) Shot 9 - Shot 9 - 1825 ft, 88 cal, 13.2 psi.
Shot 10 - 1125 ft, over 60 cal, 32 psi.

SECRET – RESTRICTED DATA

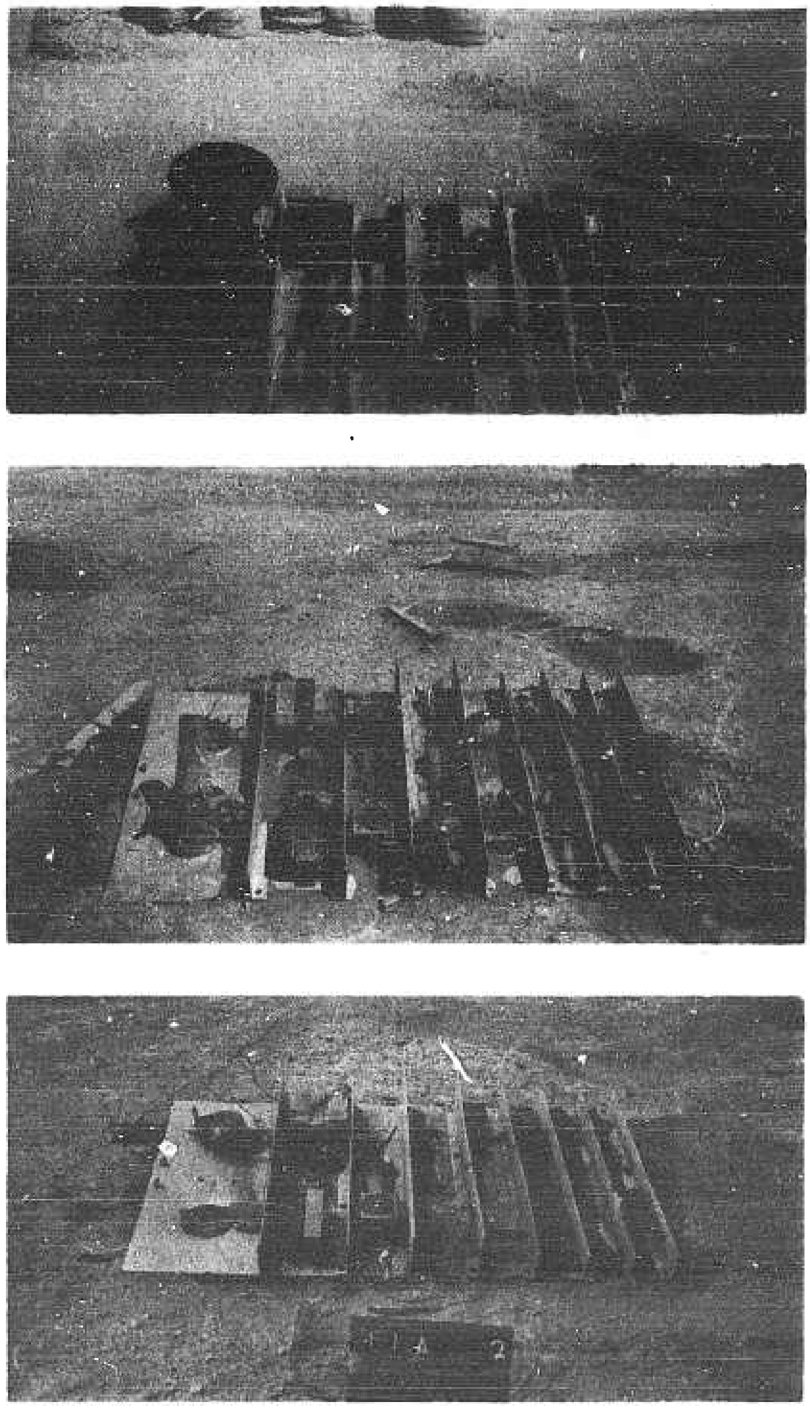


Fig. 3.71 Shots 9 and 10, Test Groups 11 and 11A, Exposure Boards, (Top-before 9, Center-after 9, Bottom-after 10) (A new Exposure Board was Positioned for Shot 10.) Shot 9 - 1825 ft 88 cal, 13.2 psi. Shot 10 - 1125 ft, over 60 cal, 32 psi.

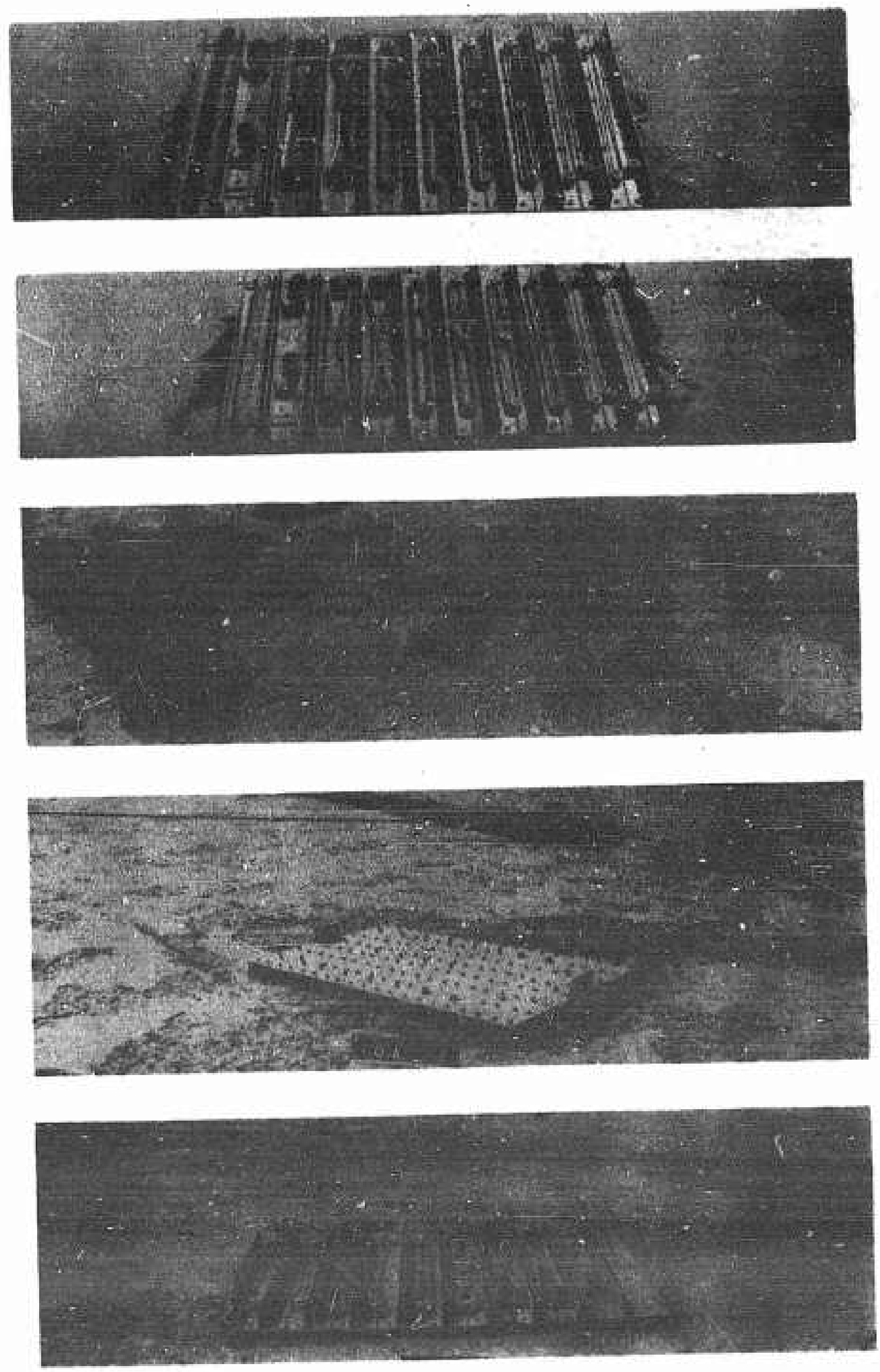


Fig. 3.72 Shots 9 and 10, Test Groups 12 and 12A, Exposure Boards. (Top—before 9, Second—after 9, Third—after 10, Fourth—Position of Board 12A, 450 ft from Original Position, Bottom—Appearance of Board after it was Turned Over.) Shot 9 - 2800 ft, 62 cal, 10.8 psi. Shot 10 - 2125 ft, over 60 cal, 7 psi.

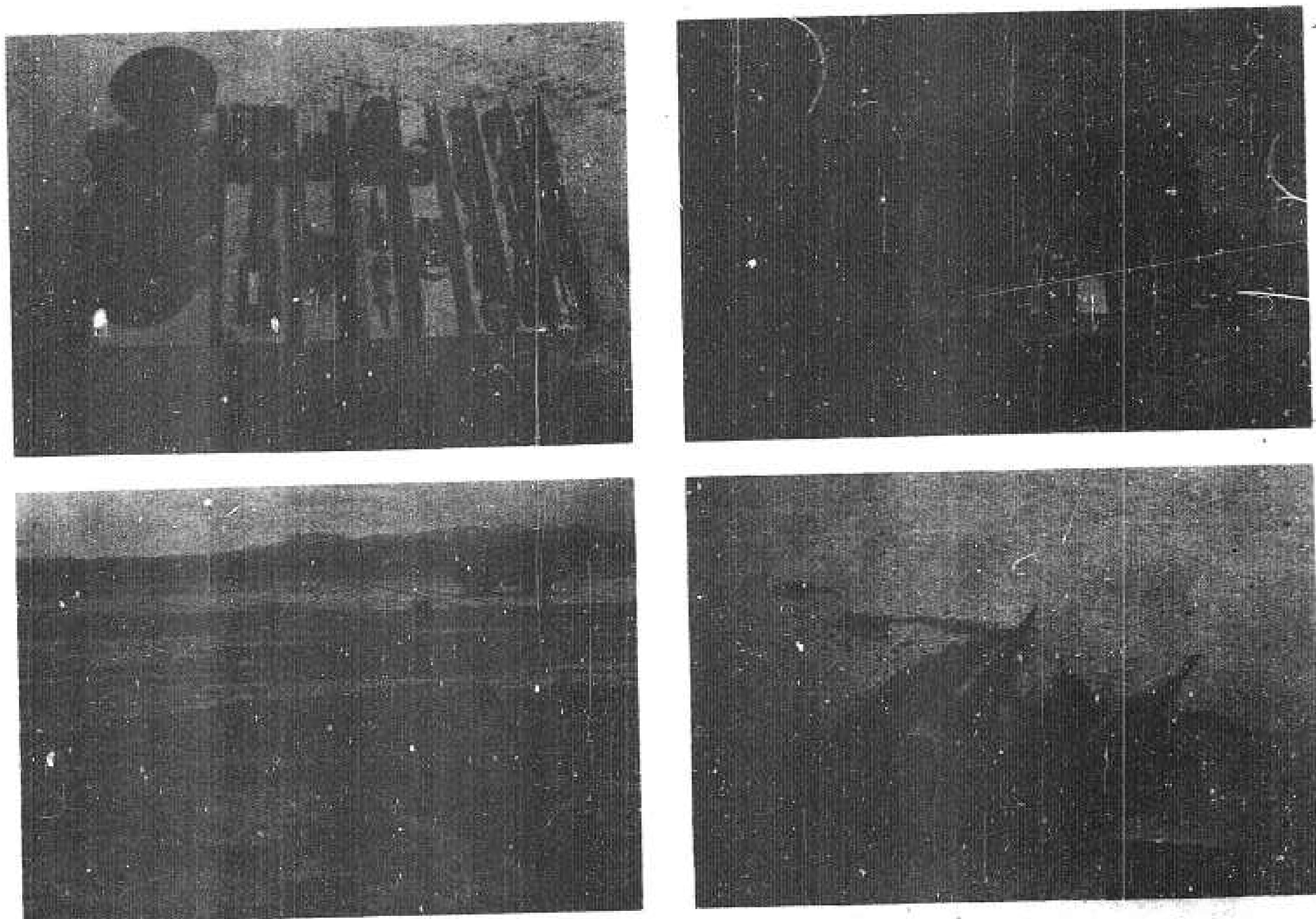


Fig. 3.73 Shots 9 and 10, Test Groups 13 and 13A, Exposure Boards. (Top left-before 9, Top right-after 9, Bottom-after 10) A New Exposure Board was Positioned for Shot 10. Bottom right-Landing Position of Board 13A, 450 ft from Original Position in Shot 10. Shot 9 - 2800 ft, 62 cal, 10.8 psi. Shot 10 - 2125 ft, over 60 cal, 7 psi.

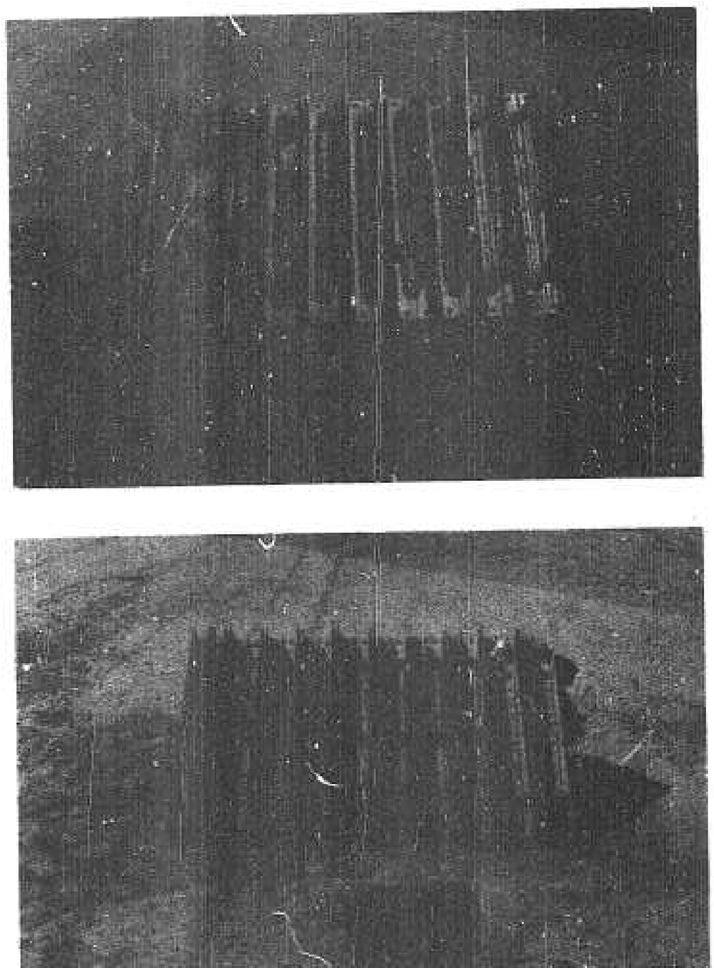


Fig. 3.74 Shot 9, Test Group 14, Exposure Boards. (Top left-before, Bottom left-after) 3825 ft, 43.5 cal. 8.6 psi.

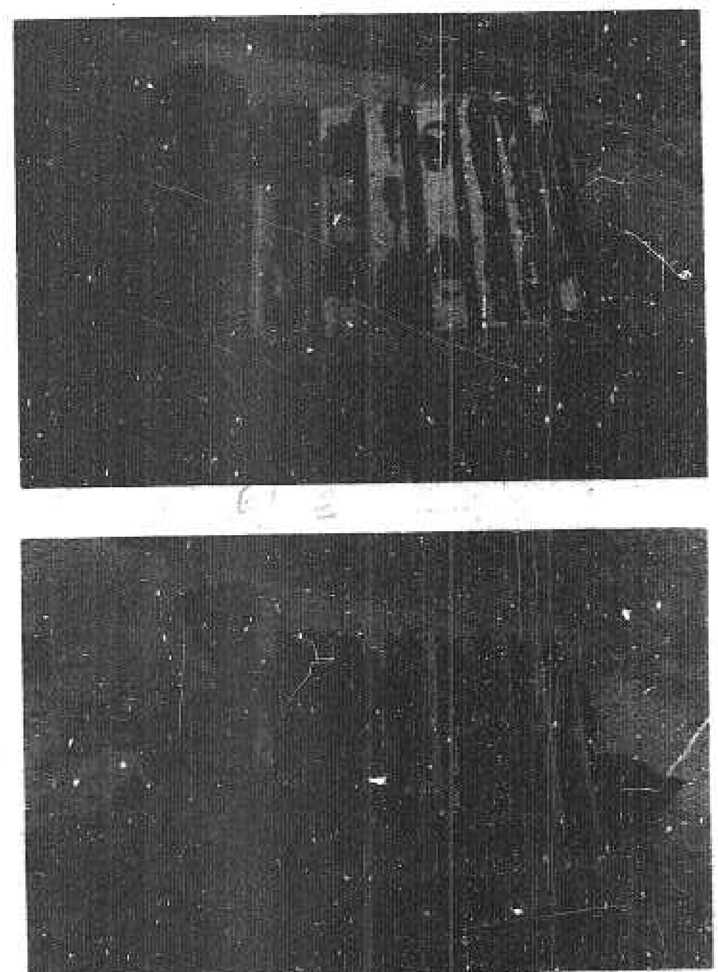


Fig. 3.75 Shot 9, Test Group 15, Exposure Board. (Top right-before, Bottom right-after) 3825 ft, 43.5 cal, 8.6 psi.

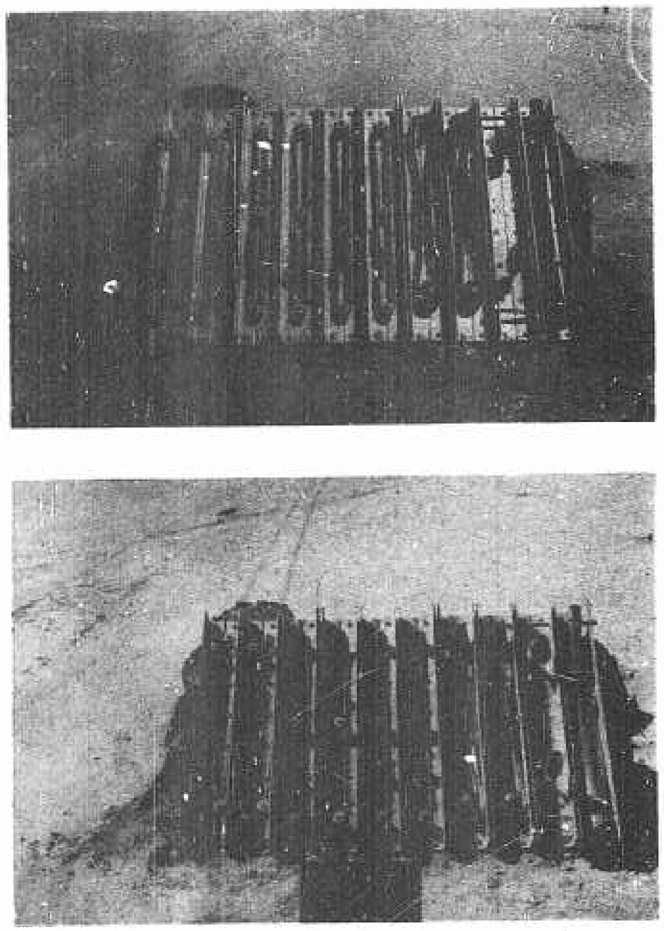


Fig. 3.76 Shot 9, Test Group 16, Exposure Board. (Top-before, Bottom-after) NOTE: The Positions of the Test Items on this Exposure Board were Inadvertently Reversed from Those of Other Exposure Boards. 4800 ft, 30.5 cal, 6.4 psi.

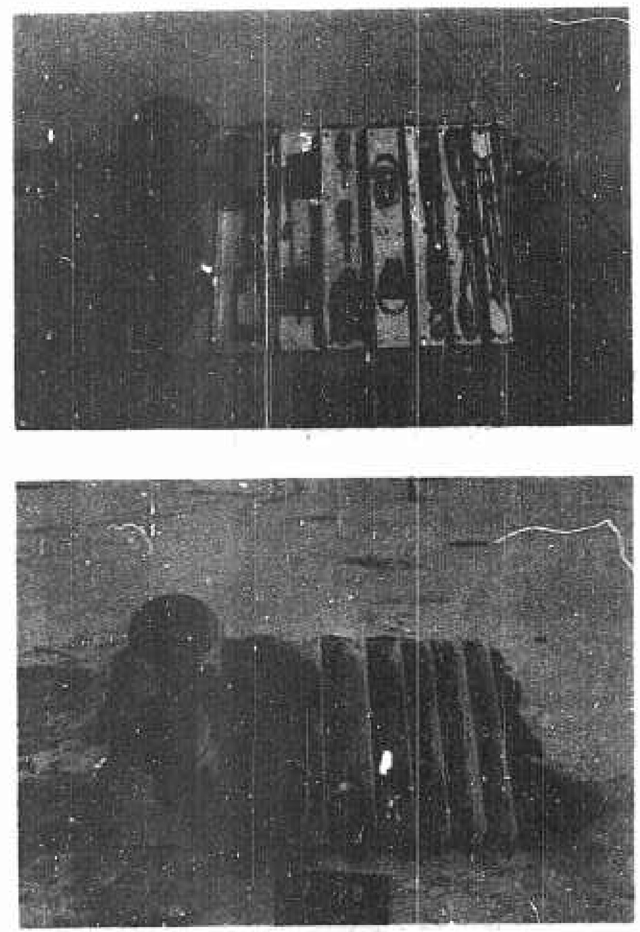


Fig. 3.77 Shot 9, Test Group 17, Exposure Board. (Top-before, Bottom-after) 4800 ft, 30.5 cal, 6.4 psi.

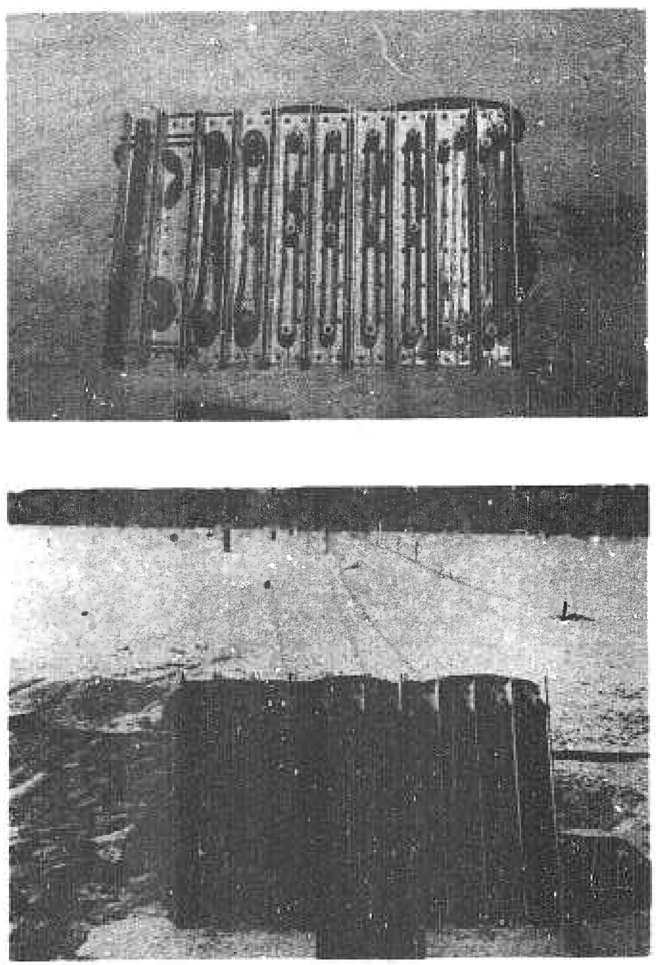


Fig. 3.78 Shot 9, Test Group 18, Exposure Board. (Top-before, Bottom-after) 5800 ft, 23.5 cal, 7.2 psi.

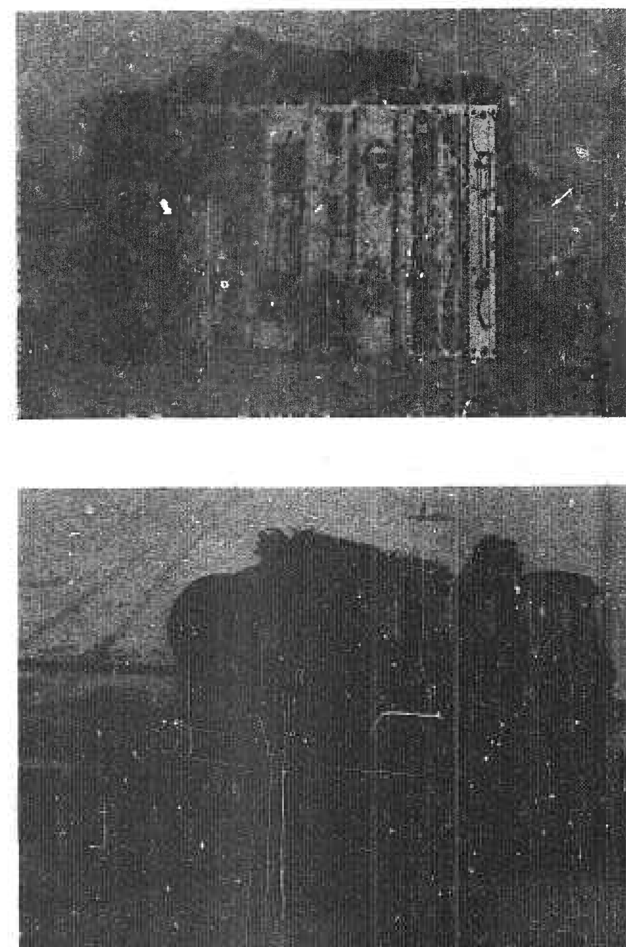


Fig. 3.79 Shot 9, Test Group 19, Exposure Board. (Top-before, Bottom-after) 5800 ft, 23.5 cal, 7.2 psi.

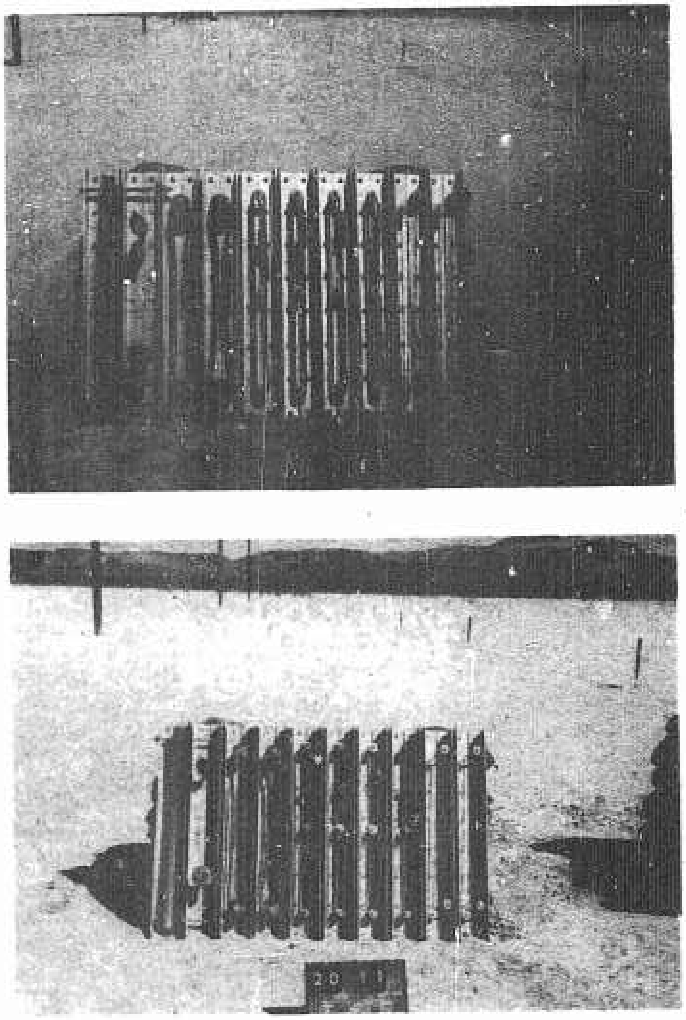


Fig. 3.80 Shot 9, Test Group 20, Exposure Board.
(Top-before, Bottom-after)
6800 ft, 16.5 cal, 4.2 psi.

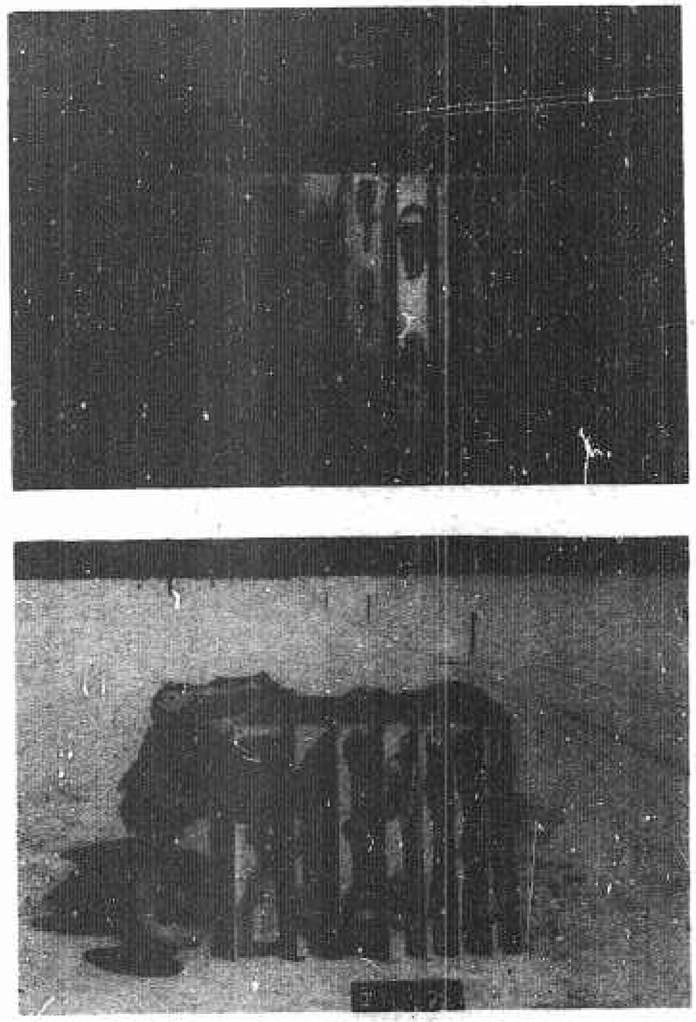


Fig. 3.81 Shot 9, Test Group 21, Exposure Board.
(Top-befcre, Bottom-after)
6800 ft, 16.5 cal, 4.2 psi.

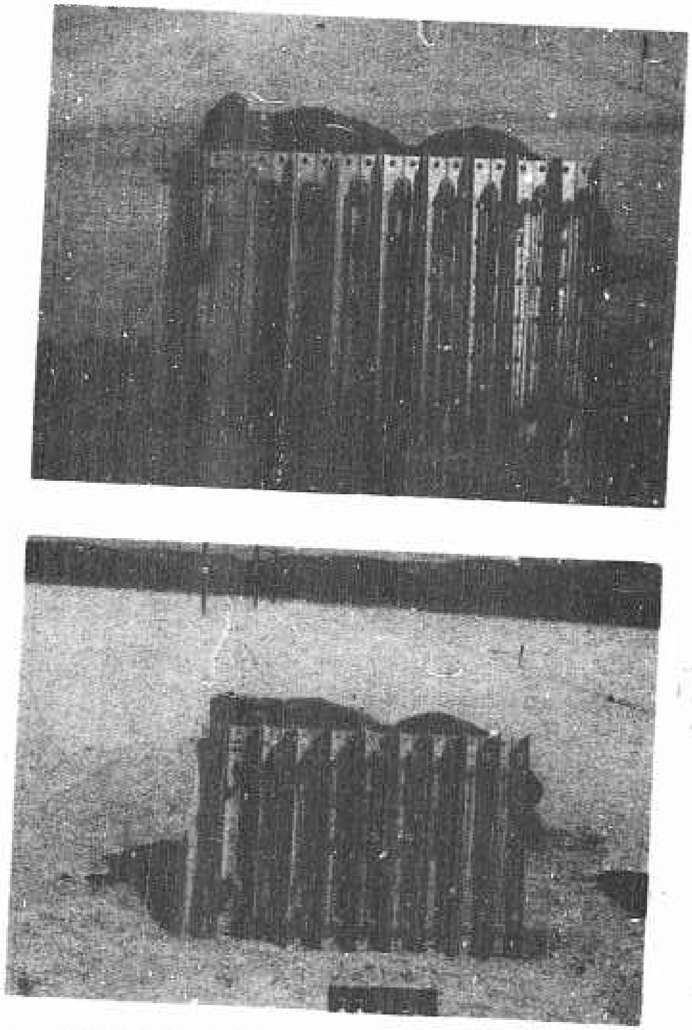


Fig. 3.82 Shot 9, Test Group 22, Exposure Board.
(Top-before, Bottom-after)
7800 ft, 10.8 cal, 3.4 psi.

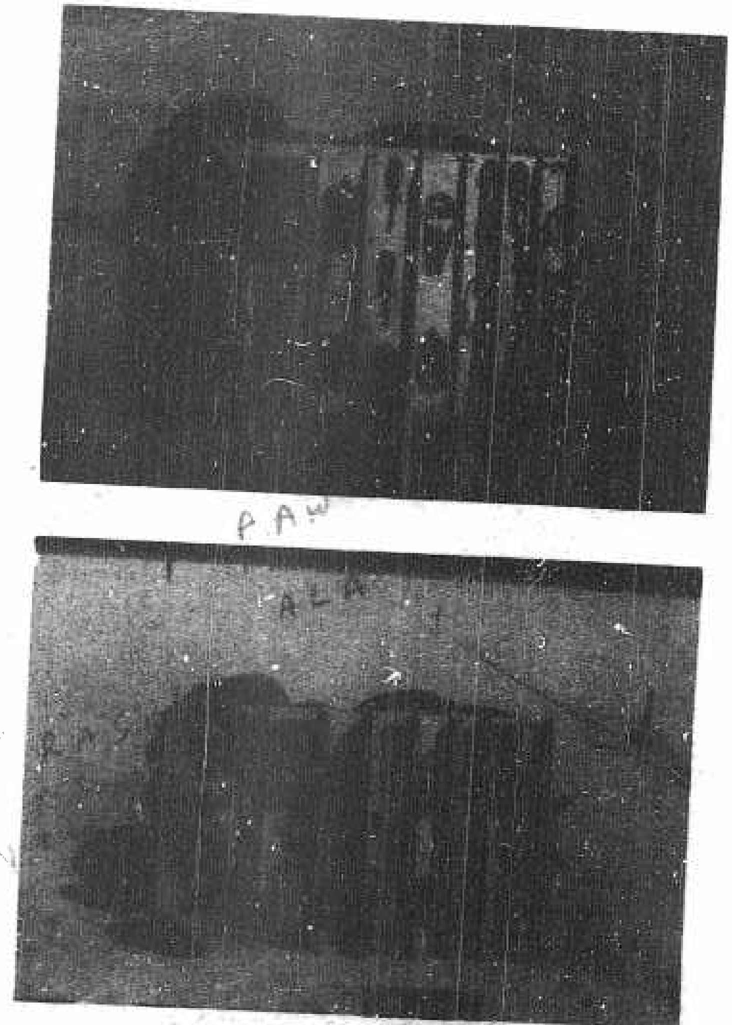


Fig. 3.83 Shot 9, Test Group 23, Exposure Board.
(Top-before, Bottom-after)
7800 ft, 10.8 cal, 3.4 psi.

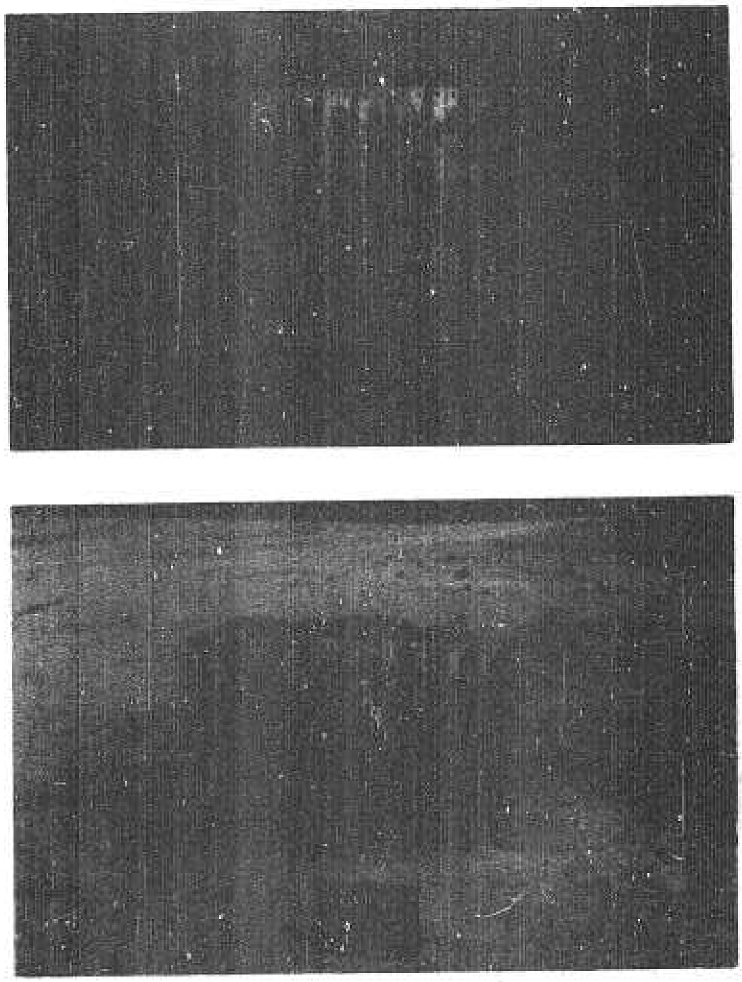


Fig. 3.84 Shot 9, Test Group 98, Exposure Board.
(Top-before, Bottom-after)
8800 ft, 9.5 cal, 3 psi.

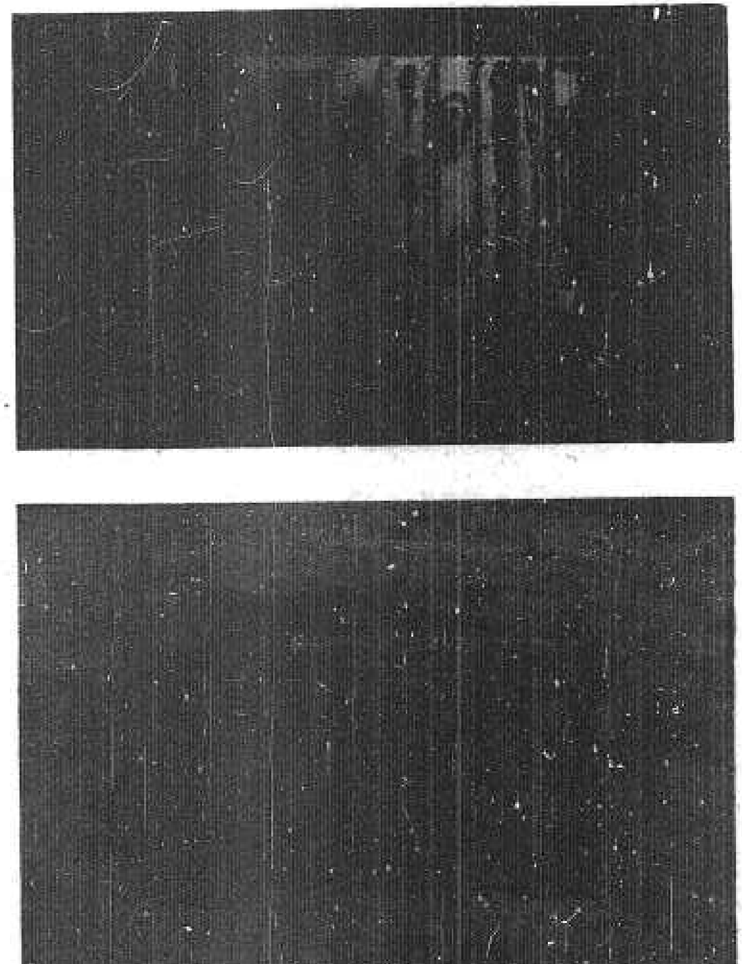


Fig. 3.85 Shot 9, Test Group 99, Exposure Board.
(Top-before, Bottom-after)
8800 ft, 9.5 cal, 3 psi

NOTE: The Increase in Angle of Exposure Boards with the Vertical as Distance from Ground Zero has Increased.

TABLE 3.10 - Damage Summary

Separate Poles - Test Groups 104A-109A (Shot 10)

Test Group No.	Ft from GZ	cal	psi	Thermal Damage	Blast Damage	Remarks
104A	300N	over 60	over 115	S	S	Pole splintered and scattered about the area.
103A	500N	over 60	over 115	S	S	Pole splintered and scattered about the area.
105A	800S	over 60	over 115	S	S	Pole splintered and scattered about the area.

order that they might receive maximum thermal effects at each location, the boards were oriented at 90° to slant range lines drawn from the centers of the boards to the expected burst position. The equipment and material displayed on these exposure boards were as follows:

Left hand boards (left to right)
- Alpeth cable, 300 pair
- (Top) Glass insulators, (bottom) Rubber insulators
- 26 pair Buna S covered cable
- Alpeth, cable, 51 pair
- Coaxial cable, neoprene
- 5 pair rubber covered cable
- 5 pair lead covered cable
- Spiral Four Cable
- Wire, WD-14/TT
- Wire, WD-1/TT

Right hand boards (left to right)
- Loudspeaker, LS-103/TIQ-2
- EE-8 (top) w/canvas case, (bottom) w/o canvas case
- Loudspeaker LS-166 (Top and Bottom)
- Cable Connector (top) Spiral Four, (center) Spiral Four (Bottom) Telephone TP-6
- Headset (top) H-16/U, (bottom) H-16/U
- Headset (top) H-33/PT, (bottom) H-33/PT
- Microphone (top) M-29/U, (bottom) M-29/U
- Headset, HS-30-U

The test items were separated from each other by aluminum spacers to reduce any secondary effects.

b. RESULTS: The exposure (display) boards and the equipment and material displayed thereon received varying degrees of thermal and blast damage. Laboratory analyses made at Coles Signal Laboratory provided additional damage criteria. A summary of the damage is shown in Tables 3.11 and 3.12. The damage is tabulated for the test items as they appear on the exposure boards reading from left to right on each board.

c. PHOTOGRAPHS: Pre- and postshots. Photographs of Test Groups 10 - 23 and 98 - 99 are shown in Figs. 3.70 - 3.85. Photographs of Test Groups 10 - 13, Shot 9 have been combined with 10A - 13A, Shot

10 and are shown in Figs. 3.70 - 3.73.

3.7.2 Exposure Boards - Test Groups 10A-13A, Shot 10 (Figs. 3.70 - 3.73)

a. DESIGN: The exposure boards used in Shot 10 were of the same type used in Shot 9. New exposure boards (Test Groups 10A - 13A) were placed in position at 1100 ft and 2100 ft from GZ.

b. RESULTS: The exposure boards at 1100 ft (Test Groups 10A - 11A) remained intact at their original positions and all test items received severe thermal and blast damage. The two exposure boards (Test Groups 12A - 13A) located at 2100 ft (over 60 cal, 8 psi) were thrown outward in a northerly direction. One board (Test Group 12A) landed about 450 ft from its original position on the left hand side of the pole line; the other board (Test Group 13A) landed about 1450 ft from its original position on the right hand side of the pole line. Some of the test items were thrown from the boards. All test items received severe damage.

TABLE 3.11 - Damage Summary

Exposure Boards - Test Groups 10, 12, 14, 16, 18, 20, 22, and 98, Shot 9

Test Group No.	Ft from GZ	cal	psi	Thermal Damage	Blast Damage	Remarks
						Alpeth Cable, 300 pair
						Same as Five Pair, Rubber covered cable
						Glass and Rubber Insulators 1, 2
11	1825	88	13.2	N	N	Slight loss of glaze on rubber insulators
13	2800	62	10.8	N	N	Slight loss of glaze on rubber insulators
15	3825	43.5	8.6	N	N	Slight loss of glaze on rubber insulators
17	4800	30.5	6.4	N	N	Slight loss of glaze on rubber insulators
19	5800	23.5	5.2	N	N	Slight loss of glaze on rubber insulators
21	6800	16.5	4.2	N	N	Slight loss of glaze on rubber insulators
23	7800	10.8	3.4	N	N	Slight loss of glaze on rubber insulators
99	8800	9.5	3	N	N	Slight loss of glaze on rubber insulators

NOTE 1: Glass insulators at all positions undamaged.

NOTE 2: After two months in laboratory the rubber insulators at 1825 and 2825 ft completely covered outside and inside the skirt with a green powder bloom which washed off with water. Insulation resistance satisfactory.

TABLE 3.11 - Damage Summary (Continued)

Test Group No.	Ft from GZ	cal	psi	Thermal Damage	Blast Damage	Remarks
26 Pair Buna S Covered Cable						
Same as Five Pair, Rubber Covered Cable						
Alpeth Cable, 51 Pair						
Same as Five Pair, Rubber Covered Cable						
Coaxial Cable, Neoprene						
Same as Five Pair, Rubber Covered Cable						
Five Pair, Rubber Covered Cable						
10	1825	88	13.2	M	N	Slight char, insulation cracked
12	2800	62	10.8	L	N	Slight char
14	3825	43.5	8.6	L	N	Slight char
16	4800	30.5	6.4	L	N	Slight char
18	5800	23.5	5.2	N	N	No damage
20	6800	16.5	4.2	N	N	No damage
22	7800	10.8	3.4	N	N	No damage
98	8800	9.5	3	N	N	No damage
5 Pair Lead Covered Cable						
10	1825	88	13.2	S	N	Portions of lead sheath melted exposing paper insulation on conductors.
12	2800	62	10.8	M	N	Slight vaporization of lead sheath.
14	3825	43.5	8.6	L	N	Very light vaporization of lead sheath.
16	4800	30.5	6.4	N	N	No damage
18	5800	23.5	5.2	N	N	No damage
20	6800	16.5	4.2	N	N	No damage
22	7800	10.8	3.4	N	N	No damage
98	8800	9.5	3	N	N	No damage
Spiral Four Cable						
10	1825	88	13.2	L	N	Slight char on outer jacket.
12	2800	62	10.8	L	N	Slight char on outer jacket.
14	3825	43.5	8.6	L	N	Slight char on outer jacket.
16	4800	30.5	6.4	L	N	Slight char on outer jacket.
18	5800	23.5	5.2	L	N	Slight char on outer jacket.
20	6800	16.5	4.2	N	N	No damage
22	7800	10.8	3.4	N	N	No damage
98	8800	9.5	3	N	N	No damage

TABLE 3.11 - Damage Summary (Continued)

Test Group No.	Ft from GZ	cal	psi	Thermal Damage	Blast Damage	Remarks
Wire WD-14/TT						
10	1825	88	13.2	S	N	Insulation melted, conductors fused.
12	2800	62	10.8	S	N	Insulation melted, conductors fused.
14	3825	43.5	8.6	S	N	Insulation melted, conductors fused.
16	4800	30.5	6.4	M	N	Nylon burned off, polyethylene cracked exposing conductors.
18	5800	23.5	5.2	M	N	Nylon burned off, polyethylene cracked exposing conductors.
20	6800	16.5	4.2	M	N	Nylon burned off, polyethylene cracked exposing conductors.
22	7800	10.8	3.4	M	N	Nylon burned off, polyethylene cracked exposing conductors.
98	8800	9.5	3	M	N	Nylon burned off, polyethylene cracked exposing conductors.
Wire WD-1/TT						
10	1825	88	13.2	S	N	Insulation melted, exposing conductors.
12	2800	62	10.8	S	N	Insulation melted, exposing conductors.
14	3825	43.5	8.6	S	N	Insulation melted, exposing conductors.
16	4800	30.5	6.4	L	N	Nylon burned off, exposing polyethylene insulation.
18	5800	23.5	5.2	L	N	Nylon burned off, exposing polyethylene insulation.
20	6800	16.5	4.2	L	N	Nylon burned off, exposing polyethylene insulation.
22	7800	10.8	3.4	L	N	Slight char
98	8800	9.5	3	N	N	No damage

TABLE 3.12 - Damage Summary

Exposure Boards - Test Groups 11, 13, 15, 17, 19, 21, 23, and 99, Shot 9

Test Group No.	Ft from GZ	cal	psi	Thermal Damage	Blast Damage	Remarks
			Loudspeaker LS-103/TIQ-2			
11	1825	88	13.2	N	S	Horns blown 75 to 150 ft, cone of 1 loudspeaker blown 75 ft. No thermal damage. Horns and cone of one loudspeaker blown 100 ft.
13	2800	62	10.8	N	S	No thermal damage.
15	3825	43.5	8.6	N	M	Paint on speaker horns slightly blistered, 1 loudspeaker intact, horn 1 loudspeaker partially dislodged and bent, paint blistered, both speakers intact.
17	4800	30.5	6.4	N	N	No damage
19	5800	23.5	5.2	N	N	No damage
21	6800	16.5	4.2	N	N	No damage
23	7800	10.8	3.4	N	N	No damage
99	8800	9.5	3	N	N	No damage
			EE-8 Field Telephone w/Canvas Case			
11	1825	88	13.2	L	N	Canvas case rubber insulation slightly scorched. No blast damage.
13	2800	62	10.8	L	N	Canvas case slightly more scorched than at 1825 ft. No blast damage.
15	3825	43.5	8.6	L	N	No damage
17	4800	30.5	6.4	L	S	Canvas case and rubber insulation slightly charred, blast damaged internal parts of telephone. Canvas case slightly scorched.
19	5800	23.5	5.2	N	N	No blast damage
21	6800	16.5	4.2	N	N	Canvas case slightly scorched. No blast damage.
23	7800	10.8	3.4	N	N	Slight scorching of canvasas.
99	8800	9.5	3	N	N	No damage.
			EE-8 Field Telephone (chassis) w/o Canvas Case			
11	1825	88	13.2	L	S	Slight charring of rubber insulation and bakelite. Blast damaged internal parts.

TABLE 3.12 - Damage Summary (Continued)

Test Group No.	Ft from GZ	cal	psi	Thermal Damage	Blast Damage	Remarks
13	2800	62	10.8	L	S	Slight charring of rubber insulation and bakelite. Blast damaged internal parts.
15	3825	43.5	8.6	L	S	Slight charring of rubber insulation and bakelite. Blast damaged internal parts.
17	4800	30.5	6.4	L	S	Slight charring of rubber insulation and bakelite. Blast damaged internal parts.
19	5800	23.5	5.2	N	S	Slight charring of rubber insulation and bakelite. Blast damaged internal parts.
21	6800	16.5	4.2	N	S	Slight charring of rubber insulation and bakelite. Blast damaged internal parts.
23	7800	10.8	3.4	N	S	Slight charring of rubber insulation and bakelite. Blast damaged internal parts.
99	8800	9.5	3	N	S	No thermal damage. Blast damaged internal parts.

Loudspeakers LS-166

11	1825	88	13.2	S	N	Holes burned in loudspeaker of cone.
13	2800	62	10.8	S	N	Holes burned in loudspeaker of cone.
15	3825	43.5	8.6	M	N	Light charring of case.
17	4800	30.5	6.4	N	N	Negligible
19	5800	23.5	5.2	N	N	Negligible
21	6800	16.5	4.2	N	N	Negligible
23	7800	10.8	3.4	N	N	Negligible
99	8800	9.5	3	N	N	Negligible

Cable Connectors, Spiral Four

Except for slight charring of rubber insulation at all positions, decreasing in intensity away from GZ, the cable connectors received negligible damage.

TP-6 Telephone

11	1825	88	13.2	S	N	Fabric cord burned, base and handset charred. No blast damage.
13	2800	62	10.8	M	N	Rubber cord, base and handset charred.

TABLE 3.12 - Damage Summary (Continued)

Test Group No.	Ft from GZ	cal	psi	Thermal Damage	Blast Damage	Remarks
15	3825	43.5	8.6	M	N	Rubber cord, base and handset charred.
17	4800	30.5	6.4	M	N	Rubber cord, base and handset charred.
19	5800	23.5	5.2	L	N	Fabric cord slightly charred.
21	6800	16.5	4.2	L	N	Fabric cord slightly charred.
23	7800	10.8	3.4	L	N	Exposed rubber and bakelite slightly charred.
99	8800	9.5	3	N	N	No damage

Headset H-16/U

These headsets received negligible damage except for slight charring of exposed rubber and bakelite at all positions, decreasing in intensity away from GZ. All headsets were operable.

Headset H-33/PT

Same as for M-29 Microphone except that the membranes, transmitter caps on one handset at 2800 ft were ruptured by blast and scorched and were non-operable. All other handsets were operable.

Microphone M-29/U

These headsets received slight charring of exposed rubber parts at all positions decreasing in intensity away from GZ. All microphones were operable.

All four of these exposure boards showed about 300 milliroentgens residual gamma radiation after Shot 10. They were washed off with water at the decontaminating facility. This process failed to eliminate the contamination and the boards were retained at the test site to "cool off." They will be returned to the Signal Corps Engineering Laboratories at a later date for an analysis of the test items.

This situation is mentioned in the report in association with questions which may be asked regarding residual contaminating of Signal items. It will be extremely difficult to decontaminate complex, relatively delicate signal items should they become contaminated. Gamma radiation measurements will be required and from these measurements it can be determined whether or not decontamination can be attempted. If the equipment and material responds to decontamination processes all is well. If the equipment does not respond, further decisions will be required as to whether the residual radiation is sufficient to become injurious to personnel or can be reused with safety. Trained personnel are required in this type of analysis and evaluation to avoid an overestimation, likewise an under-estimation of the situation. Watches of

the luminous dial type which are continuously being worn on the wrist often register greater gamma activity on a geiger counter than do items exposed to a high air burst atomic weapon. Persons hesitant to analyze exposed equipment in the laboratory when shown this simple demonstration were satisfied. A vitally needed radio set could, after exposure, show no injurious residual contamination were instruments available to check its activity, although this set could be discarded through lack of proper understanding for fear that it is contaminated. These illustrations point up the requirement for proper training for all concerned in the factors involved in analyzing equipment and material subjected to atomic weapons.

A damage summary for these test groups is shown in Tables 3.13 and 3.14.

c. PHOTOGRAPHS: Pre- and post-Shot 10 photographs for these test groups have been combined with photographs of Test Groups 10 - 13, Shot 9, and are shown in Figs. 3.70 - 3.73.

3.8 TOWERS - TEST GROUPS 33 - 36, SHOT 9 (FIGS. 3.86 - 3.93)

Four aluminum Towers Type AB-216 were assembled and guyed four ways with nylon covered 7/32 in. diameter steel guys. The three 120 ft towers were guyed at six levels and the 204 ft tower was guyed at nine levels. The 120 ft towers were placed at 3350, 4350, and 5350 ft from GZ. The 204 ft tower was installed at 6350 ft from GZ. At the top of each of the towers, except Test Group 33, 3350 ft from GZ, a pair of 6 ft diameter parabolic microwave radio relay station reflectors were mounted. In each case the 6 ft wide face was oriented toward the blast and guyed so that the blast forces would act between two sets of guys. A limited amount of high speed photography of the tower action during the shot was obtained. A damage summary of these test groups is shown in Table 3.15.

3.8.1 Tower - Test Group 33, Shot 9 (Figs. 3.86 - 3.87)

a. DESIGN: Scaffold Tower, Type AB-216/U, 120 ft high, consisting of Tower AB-216/U, Guy Kit MK-99/U and Tower Section AB-298/U.

Installation was located 3350 ft from GZ. No equipment other than the tower sections were exposed on this installation. Auxiliary items such as Davit MX-1215/U and the hoist line assembly were removed from the structure. No antenna parabolic reflectors were installed. The exposed area subject to wind loading consisted only of that presented by the tower members. The tower was painted with orange and white stripes in accordance with CAA regulations.

b. RESULTS: Severe damage by blast forces. Tower collapsed. Study of high speed photography indicates that basic tower failure occurred between ground and the first guy level. The base and third section from bottom were demolished. Members were severely bent or broken. Adjustable feet at base section were severed. Examination of individual tower sections revealed that only 5 sections could be reused. Fifteen sections were sufficiently damaged to require replacement. Small diagonals (1 inch diameter tubing) in many of the damaged sections failed in either tension or compression. The tensile failure caused the two rivets to be sheared at either end of the diagonal. The compression

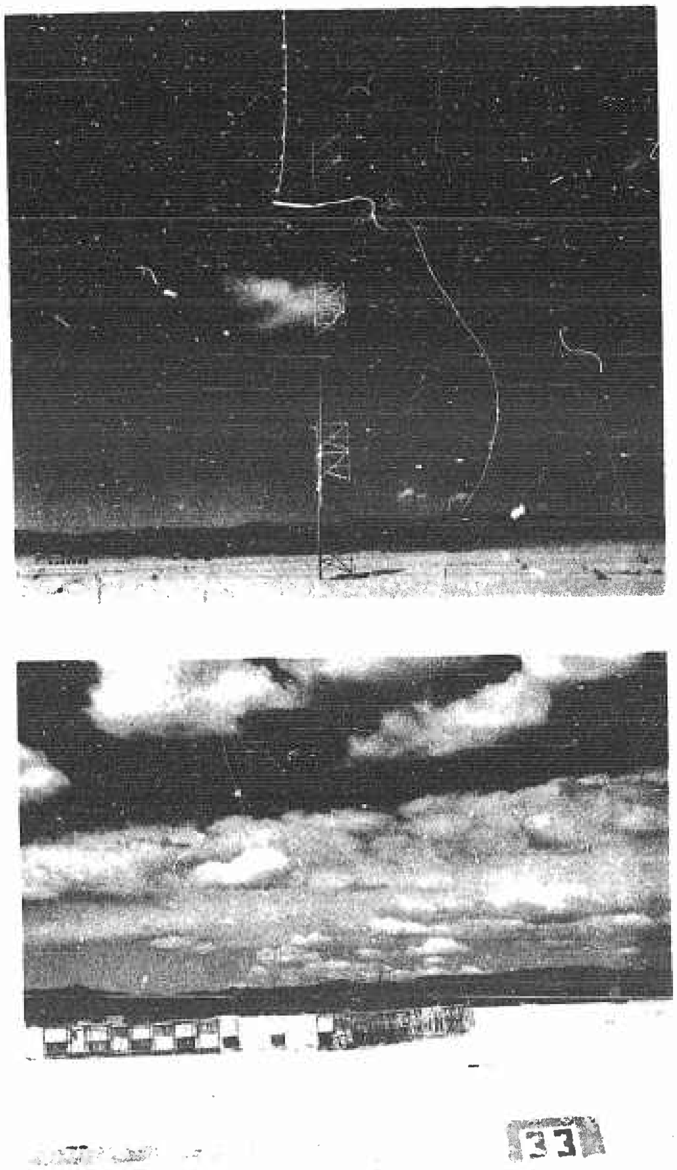


Fig. 3.86 Shot 9, Test Group 33, Tower, 120 ft.
(Top-before, Bottom-after)
3350 ft, 51.5 cal, 9.8 psi.

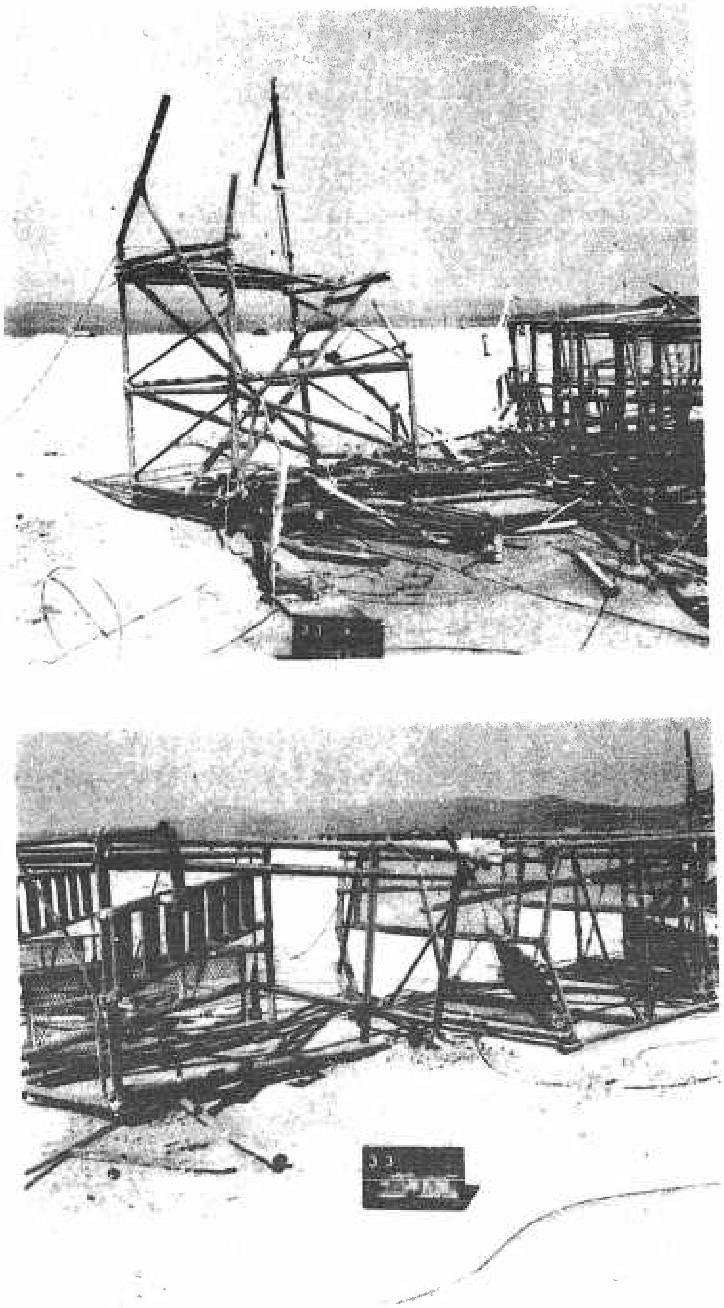


Fig. 3.87 Shot 9, Test Group 33, Tower, 120 ft. (See Fig. 3.129)
(Top-after, Bottom-after) 3350 ft, 51.5 cal, 9.8 psi.

TABLE 3.13 - Damage Summary Exposure Boards

Test Groups 10A and 12A - Shot 10

Test Group No.	Ft from GZ	cal	psi	Thermal Damage	Blast Damage	Remarks
Alpeth Cable, 300 Pair						
10A 12A	1125 2125	over 60 over 60	32 7	S	L	Jacket severely burned.
Glass and Rubber Insulators						
10A 12A	1125 2125	over 60 over 60	32 7	S	S	Glass insulator missing. Rubber insulator burned and cracked.
26 Pair Buna Covered Cable						
10A 12A	1125 2125	over 60 over 60	32 7	L	L	Jacket burned.
Alpeth Cable, 51 Pair						
10A 12A	1125 2125	over 60 over 60	32 7	L	L	Jacket burned.
Coaxial Cable, Neoprene						
10A 12A	1125 2125	over 60 over 60	32 7	L	L	Jacket burned.
5 Pair Lead Covered Cable						
10A 12A	1125 2125			S	S	Conductor exposed and burned.
Spiral Four Cable						
10A 12A	1125 2125	over 60 over 60	32 7	S	S	Jacket burned, conductors exposed.
Wire WD-14/TT						
10A 12A	1125 2125	over 60 over 60	32 7	S	S	Jacket burned, conductors exposed.
Wire WD-1/TT						
10A 12A	1125 2125	over 60 over 60	32 7	S	S	Jacket burned, conductors exposed.

TABLE 3.13 - Damage Summary Exposure Boards (Continued)

Test Group No.	Ft from GZ	cal	psi	Thermal Damage	Blast Damage	Remarks
				Lead Covered Cable		
10A	1125	over 60	32			
12A	2125	over 60	7	S	S	Jacket burned, conductors exposed.

Exposure boards test group 10A all showed approximately 300 milliroentgens residual gamma radiation after Shot 10 and were retained at the test site temporarily. No laboratory analysis of damage is available at the time of this final report.

TABLE 3.14 - Damage Summary Exposure Boards

Test Groups 11A and 13A - Shot 10

Test Group No.	Ft from GZ	cal	psi	Thermal Damage	Blast Damage	Remarks[1/]
				Loudspeakers LS-103/TIQ-2		
11A	1125	over 60	32			External and internal thermal
13A	2125	over 60	7	S	S	and blast damage.
				EE-8 Field Telephone W/Canvas Case		
11A	1125	over 60	32			External and internal thermal
13A	2125	over 60	7	S	S	and blast damage.
				EE-8 Field Telephone (Chassis) W/o Canvas Case		
11A	1125	over 60	32			External and internal thermal
13A	2125	over 60	7	S	S	and blast damage.
				Loudspeakers LS-166		
11A	1125	over 60	32			External and internal thermal
13A	2125	over 60	7	S	S	and blast damage.
				Cable Connectors, Spiral Four		
11A	1125	over 60	32			External and internal thermal
13A	2125	over 60	7			and blast damage.
				TP-6 Telephone		
11A	1125	over 60	32			External and internal thermal
13A	2125	over 60	7	S	S	and blast damage.

TABLE 3.14 - Damage Summary, Exposure Boards (Continued)

Test Group No.	Ft from GZ	cal	psi	Thermal Damage	Blast Damage	Remarks 1/
Headset H-16/U						
11A 13A	1125 2125	over 60 over 60	32 7	S	S	External and internal thermal and blast damage.
Headset H-33/PT						
11A 13A	1125 2125	over 60 over 60	32 7	S	S	External and internal thermal and blast damage.
Microphone M-29/U						
11A 13A	1125 2125	over 60 over 60	32 7	S	S	External and internal thermal and blast damage.
Headset HS-30/U						
11A 13A	1125 2125	over 60 over 60	32 7	S	S	External and internal thermal and blast damage.

1/ Exposure Boards Test Group 11A all showed approximately 300 milliroentgens residual gamma radiation after Shot 10 and were retained at the test site temporarily. No laboratory analysis of damage is available at the time of this final report.

failure caused the diagonal to buckle. A common failure on many damaged sections occurred at the welding joint feet between sections. The welds failed in tension. The damage to sections which require replacement included bent, broken or twisted members in addition to the welding and small diagonal failures described. All guys, anchors, and hardware items remained intact and reusable except for some of the shackles at guy to anchor terminations which were badly deformed. Thermal radiation caused light damage to that portion of the surface on all members which were "seen" by the detonation. Painted members showed evidence of charring. The members painted white showed less charring than the orange painted members. The nylon covering on the steel wire rope guys showed evidence of fusing. In some instances short lengths of the nylon had burned sufficiently to expose the steel wire rope. The exposed top surfaces of the base timbers were slightly charred.

c. PHOTOGRAPHS: Pre- and post-Shot 9 photographs of Test Group 33 are shown in Figs. 3.86 and 3.87.

3.8.2 Tower - Test Group 34, Shot 9 (Figs. 3.88 and 3.89)

a. DESIGN: Scaffold Tower Type AB-216/U, 120 ft high consisting of Tower AB-216/U, Guy Kit MK-99/U and Tower Section Set AB-298/U.

Installation was located at 4400 ft from GZ. Two 6 ft diameter perforated parabolic reflectors were mounted side by side to

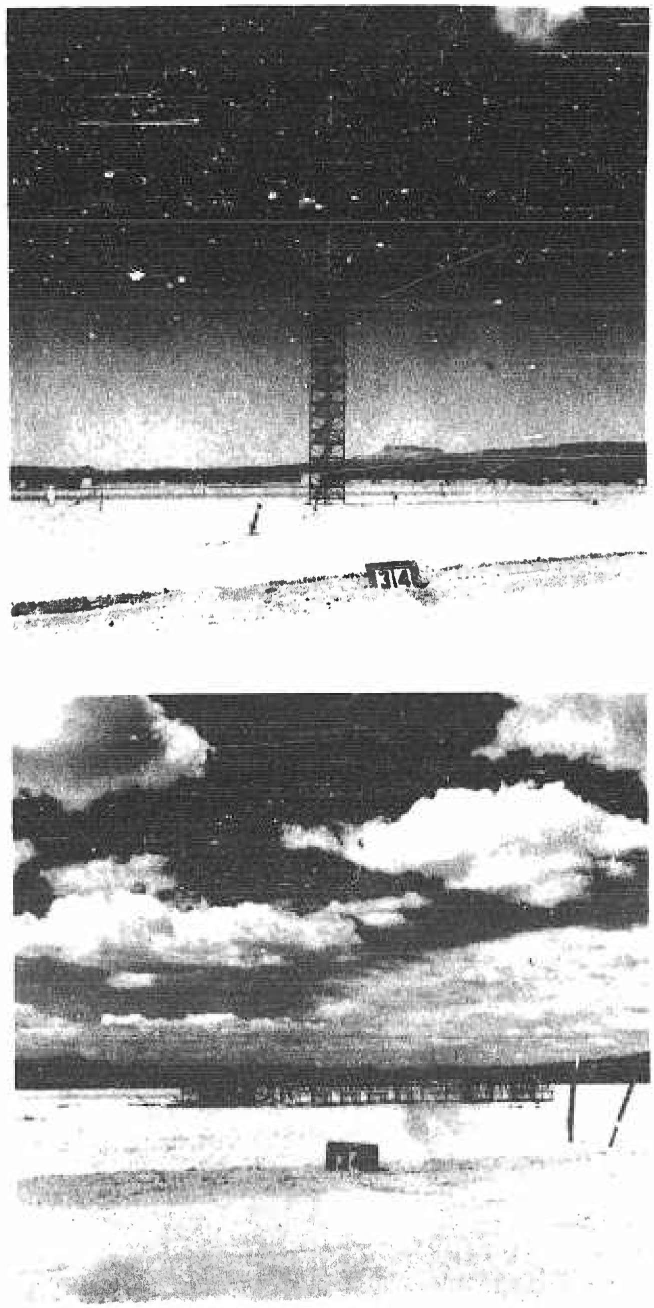


Fig. 3.88 Shot 9, Test Group 34, Tower, 120 ft.
(Top-before, Bottom-after)
4350 ft, 36 cal, 7.2 psi.

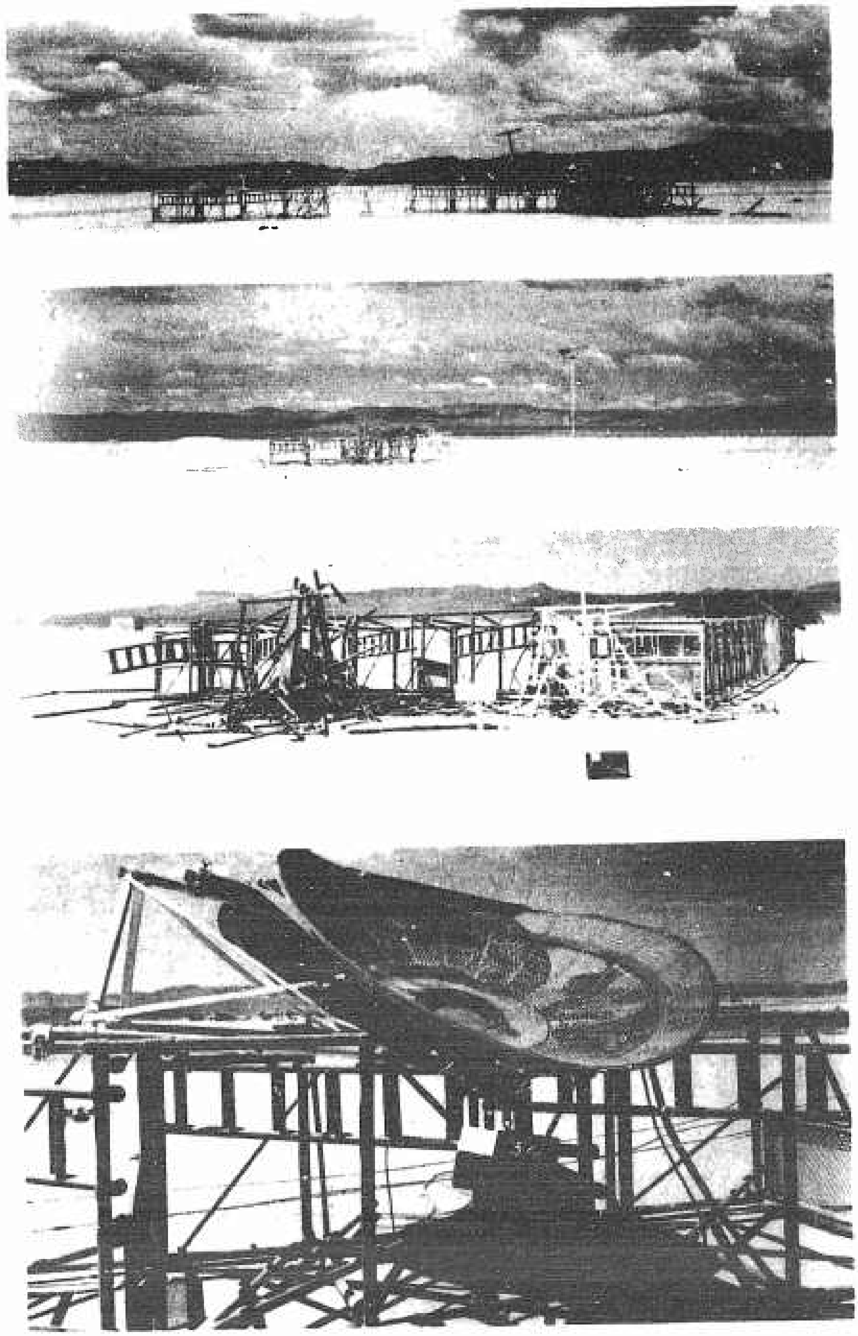


Fig. 3.89 Shot 9, Test Group 34, Tower, 120 ft.
(All after Photos Showing Damage Details.)
4350 ft, 36 cal, 7.2 psi.

the Antenna Support AB-296/G supplied as a component of the tower. The antenna assembly weighed 400 pounds. The antenna assembly was installed at a height of 114 ft with the reflectors facing GZ. An outrigger platform, Tower Bracket MT-1157/G weighing 155 lb, was mounted at a height of 90 ft on the 6 ft side facing away from GZ. All accessory items used during the tower and antenna support erection, such as Davit MX-1215/U and the hoist line assembly, were removed from the structure. The tower was painted with orange and white stripes except for the lower eight sections which were painted olive drab.

b. RESULTS: Blast forces caused severe damage. Tower collapsed. None of the tower sections remained undamaged and servicing of the installation would require replacement of all sections. All guys and hardware items remained intact and were reusable except for some shackles at guy to anchor terminations which deformed but did not fail. The threaded base plate pins from 3 of the 4 base plate assemblies were torn free of the base plates. Severe damage to the section supporting the Antenna Support AB-296/G, the perforated parabolic reflectors, and the Tower Bracket MT-1157/G was apparently caused by the collapse of the tower. Small diagonals in many of the sections failed either in tension or in compression. A common failure occurred at the welding of the joint feet between sections. The welds failed in tension. All sections had members which were bent, broken or twisted. Thermal radiation caused light damage to the surfaces of all members "seen" by the detonation. Paint charring occurred in varying degrees. White paint showed the least charring, olive drab paint the most. Orange paint showed slightly more charring than the white paint. The nylon covering on the steel wire rope guys showed evidence of fusing.

c. PHOTOGRAPHS: Pre- and postshot photographs of Test Groups 34 are shown in Figs. 3.88 and 3.89.

3.8.3 Tower - Test Group 35, Shot 9 (Fig. 3.90)

a. DESIGN: Scaffold Tower, Type AB-216/U, 120 ft high, consisting of Tower AB-216/U, Guy Kit MK-99/U, and Tower Section Set AB-298/U.

Installation was located at 5350 ft from GZ. Two 6 ft diameter perforated parabolic reflectors were mounted side by side to a common frame and erected at a height of 114 ft with the reflectors facing GZ. An outrigger platform, Scaffold Tower Bracket MT-1157/G was mounted on the 6 ft side facing away from GZ at a height of 90 ft. Davit MX-1215/U and the manila hauling line were left mounted to the structure. The tower was painted with orange and white stripes in accordance with CAA regulations.

b. RESULTS: Severe damage by blast forces. Tower did not collapse but received sufficient damage to leave it unsafe for use. Parabolic reflectors, Davit MX-1215/U and the manila hauling line received no blast damage. Scaffold Tower Bracket MT-1157/G was slightly distorted. The tower base section had the two vertical members facing GZ bent toward the inside of the tower. The assembled tower twisted approximately 10° from the forth guy level to the top. The section above the fourth guy level was severely damaged with members twisted and bent. Some of the shackles at guy to anchor terminations were bent.

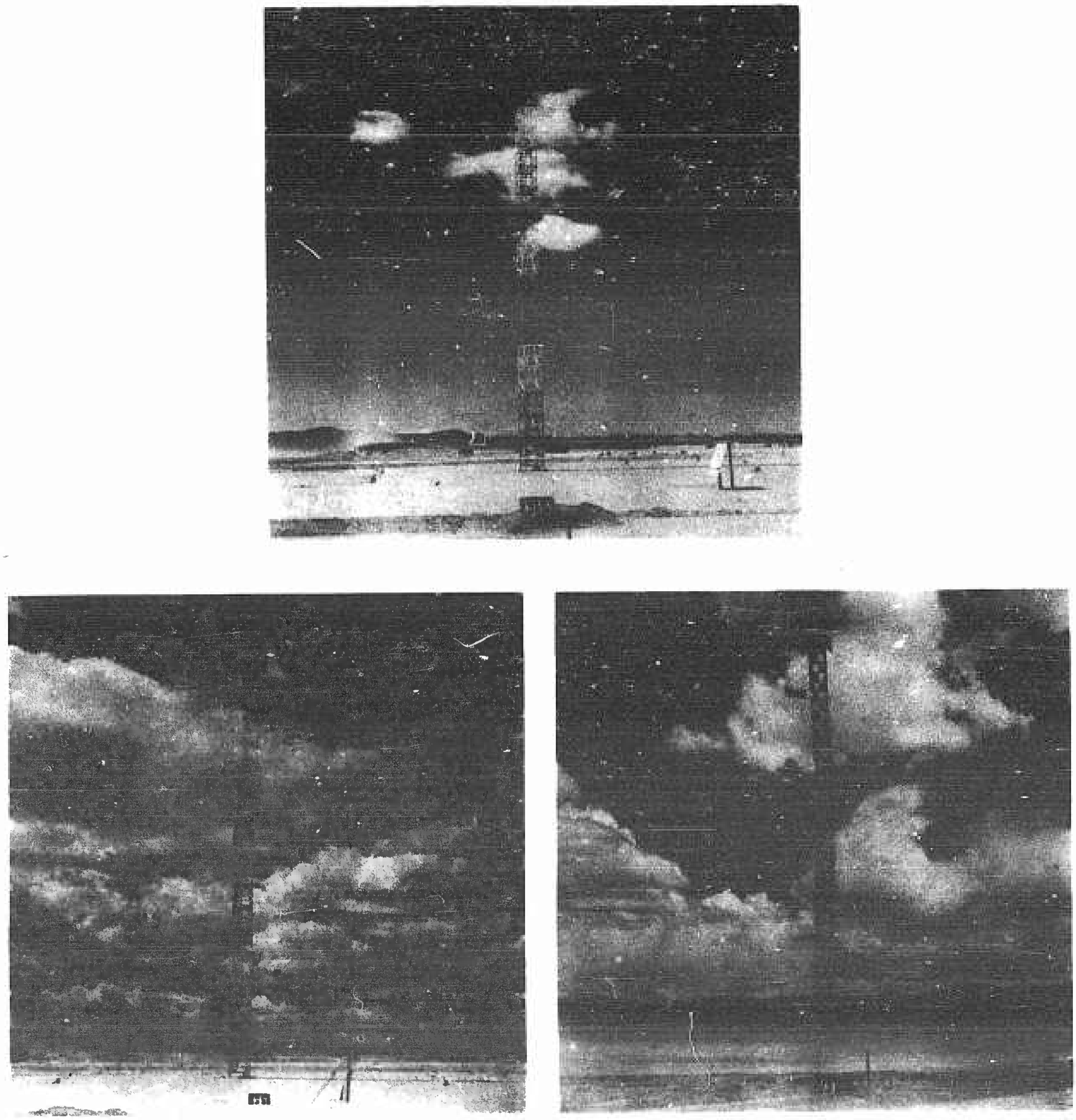


Fig. 3.90 Shot 9, Test Group 35, Tower, 120 ft. (Top-before, Bottom left-Side View Looking West-after; Bottom Right-Side View Looking East-after.) (Note Buckle in Tower.) 5350 ft, 19.5 cal, 4.6 psi.

Slight charring of painted members and the manila hauling rope on that portion of the surface facing the blast center. The nylon covering over the steel wire rope guy showed only slight evidence of fusing.

The tower was collapsed by detaching all but the top guys from the forward anchors, then detaching one and cutting the other. Examination of the collapsed tower revealed that the joint feet between sections had welds which failed in tension in many of the sections. The parabolic reflectors, which were the only items for this installation painted olive drab, received more thermal damage to the painted surfaces exposed to the detonation than any other part of the tower. That portion of the nylon covered steel guy located at the same level showed no evidence of fusing.

c. PHOTOGRAPHS: Pre- and postshot photographs of Test Group 35 are shown in Fig. 3.90.

3.8.4 Tower - Test Group 36, Shot 9 (Figs. 3.91 through 3.93)

a. DESIGN: Scaffold Tower, Type AB-216/U, 204 ft high, consisting of Tower AB-216/U, Guy Kit MK-101/U, Accessory Kit MK-100/U, Three Tower Section Sets AB-298/U.

Installation was located at 6350 ft from GZ. Two 6 ft diameter solid parabolic reflectors were mounted side by side to a common frame and erected at a height of 198 ft with the reflectors facing GZ. Davit MX-1215/U and the manila hauling line were left mounted to the structure. The tower was painted white for its full height.

b. RESULTS: Tower received moderate damage from blast forces. The tower remained standing for its full height but could only be considered serviceable to a height of 174 ft until repairs could be made. The major failure occurred at the bottom of the 30th section, 174 ft from the ground. This is the point at which the 2nd set of guys from the top were attached. The welds of the joint feet of the 30th section failed in tension causing the two forward joints between the 29th and the 30th sections to separate. As a result the 29th and 30th sections received sufficient damage to require replacement. In addition, the small diagonals of the 30th section on the narrow side nearest the blast center buckled due to compression loading, and the small diagonals on the opposite side failed in tension. At the 198 ft height the parabolic reflectors were distorted at their centers, and the vertical members which supported the bracket to which the reflectors were mounted, were bent slightly. Davit MX-1215/U which was mounted at the 204 ft level received severe damage from the blast forces. Both vertical tubes were severed. The upper portion of the Davit assembly was blown clear of the tower but was prevented from falling to the ground by the attached hauling line which became entangled with the upper guys. The lower portion of the Davit assembly fell to the ground. The point of failure occurred above the second hanger casting from the bottom. Guy to anchor termination shackles for the upper two guy levels on those guys facing the blast center, were deformed. All guys and anchors remained intact and reusable. Thermal damage was negligible.

c. PHOTOGRAPHS: Pre- and postshot photographs of this test group are shown in Figs. 3.91, 3.92, and 3.93.

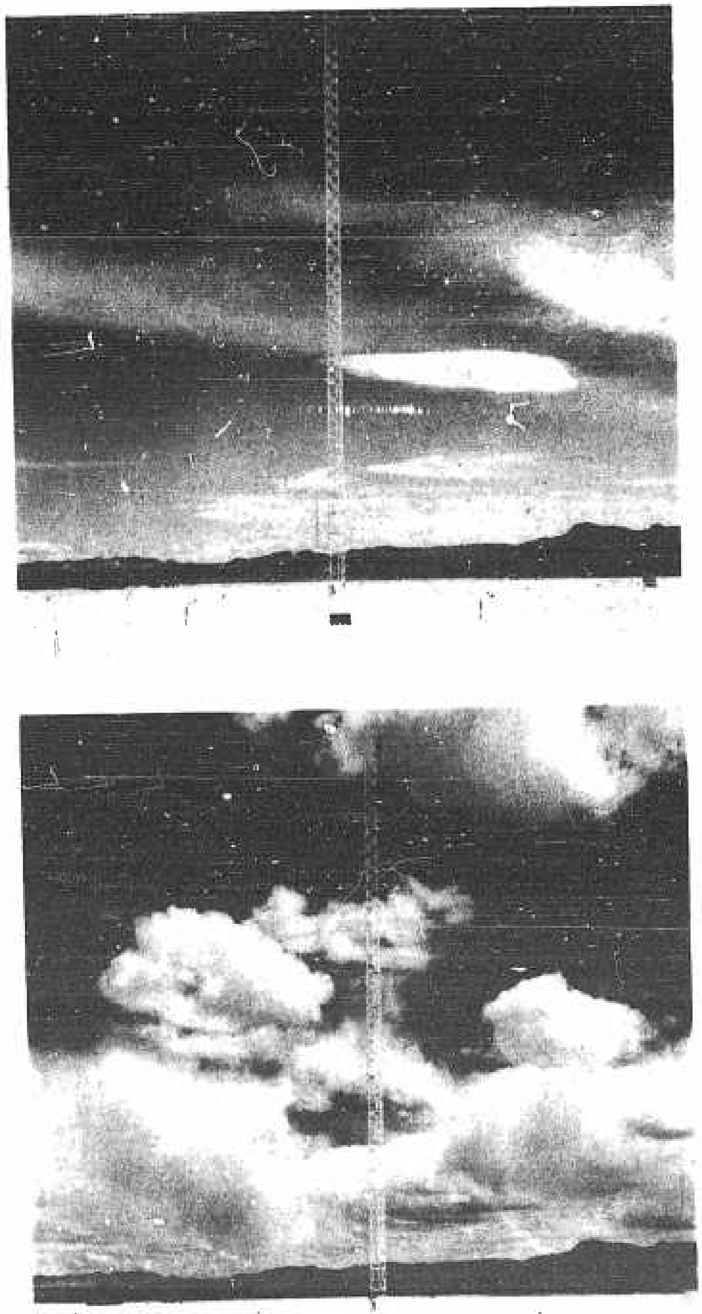


Fig. 3.91 Shot 9, Test Group 36, Tower, 200 ft.
(Top-before, Bottom-after)
6350 ft, 19.5 cal, 4.6 psi.

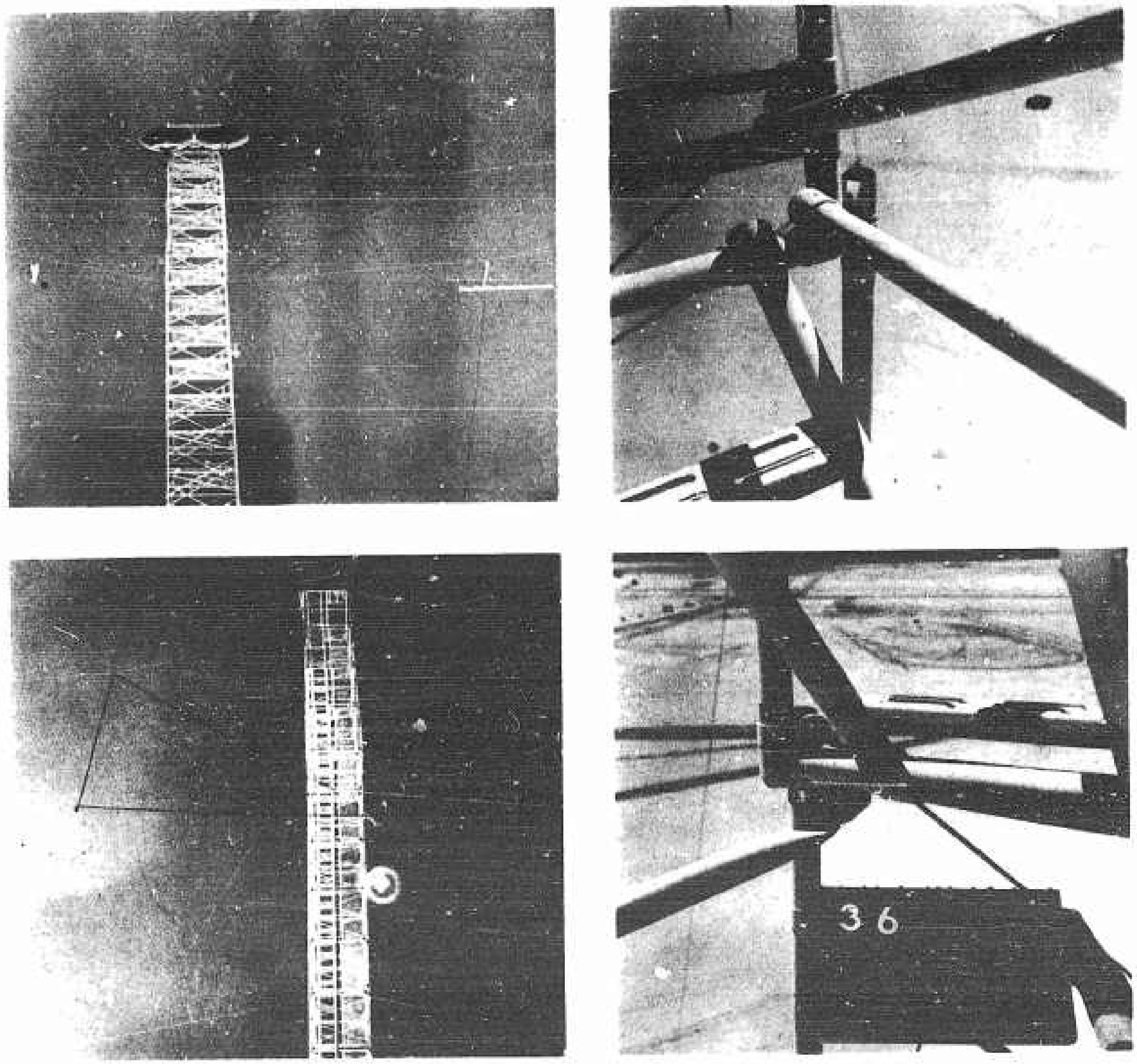
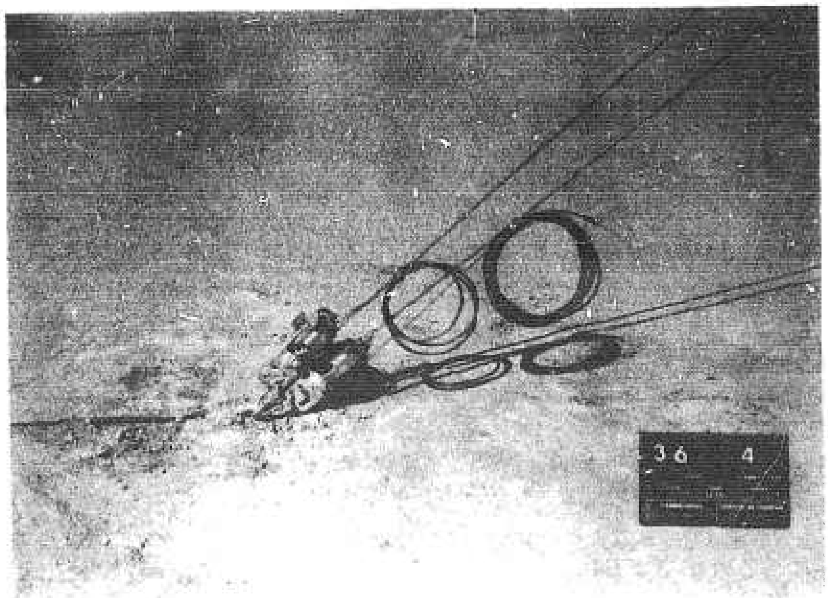


Fig. 3.92 Shot 9, Test Group 36, Tower, 200 ft. After Shot Photos. (Top left-Front View, Bottom left-Side View Looking West - Note the Deformation at Junction of 5th and 6th Tower Sections, Top Right and Bottom Right Show Section Unseated. 6450 ft, 19.5 cal, 4.6 psi.



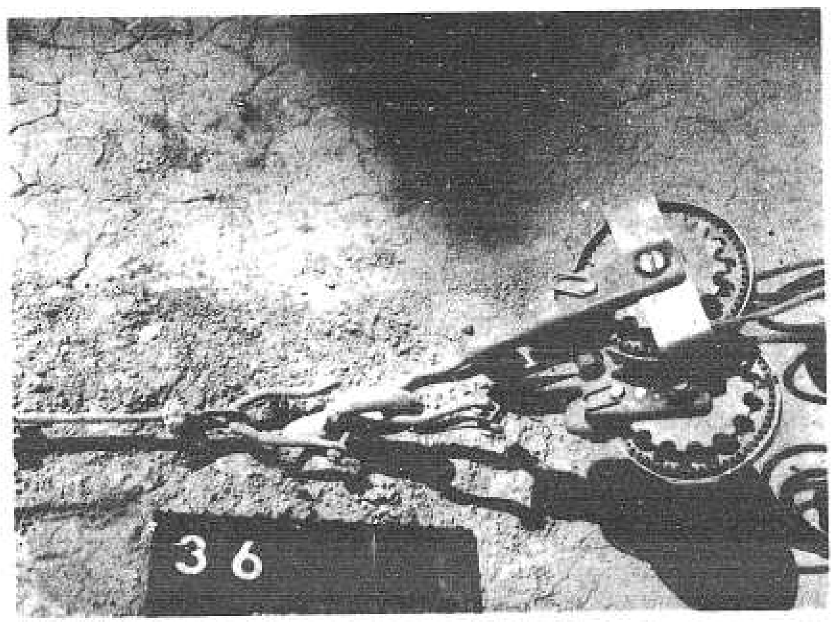


Fig. 3.93 Shot 9, Test Group 36, Tower, 300 ft, Clevice Details. (Top-before, Bottom-after) (Note Strain on Bolts.) 6350 ft, 19.5 cal, 4.6 psi.

SECRET - RESTRICTED DATA

TABLE 3.15 - Damage Summary

Towers - Test Groups 33 - 36, Shot 9

Test Group No.	Ft from GZ	cal	psi	Thermal Damage	Blast Damage	Remarks[1, 2]
33	3350	51.5	9.8	L	S	Paint burned. Tower collapsed, tower members twisted and bent and a number of welds failed.
34	4350	36	7.2	L	S	Paint scorched. Tower collapsed, tower member twisted and bent and a number of welds failed.
35	5350	26	5.6	L	S	Paint slightly scorched, tower though still standing was severely damaged.
36	6350	19.5	4.6	N	M	Paint very slightly scorched. At 174 ft two welds at the joints of vertical members failed.

Note 1: There were no broken guy wires on any of the towers.

Note 2: Many of the vertical members, and much of the tower hardware could be salvaged and reused. None of the towers were operable without major repairs.
Detailed technical analyses have been made and are available at Coles Signal Laboratory, Fort Monmouth, New Jersey.

3.9 ANTENNAS AND MASTS - TEST GROUPS 39 THROUGH 54, AND 100, SHOT 9 (FIGS. 3.94 THROUGH 3.110)

A total of 22 individual masts of six different types were erected at intervals of approximately 500 ft away from GZ starting at 4050 ft. All installations were made with an electrically non-functioning antenna supported at the top facing GZ. The masts were guyed so that the blast forces would act between two sets of guys. A damage summary of these test groups is shown in Table 3.16.

3.9.1 Antenna Support AB-26C/CR-Test Groups 39, 40, and 49, Shot 9 (Figs. 3.94 through 3.104)

a. DESIGN: Atop each mast was mounted a 6 ft diameter steel perforated parabolic reflector with two sets of outriggers attached to the reflector and guy anchors so as to resist twisting. This mast is not normally used for supporting parabolic reflectors. The back-up guy was attached to the top of the mast and oriented in line with GZ so as to resist the blast forces. The mast and reflector were painted olive drab.

b. RESULTS:

(1) Test Group 39 - located 4050 ft from GZ.

The support received severe damage from the blast forces. The support collapsed with all mast sections receiving sufficient damage to require replacement. All guys, anchors, and hardware items remained intact and serviceable. One guy chain link on the back-up guy assembly was broken. This failure was probably due to a poorly welded link. The parabolic reflector was severely damaged, probably as a result of the mast collapse. Painted surfaces and the nylon covering of steel guy wire rope exposed to the blast center received light thermal damage. Paint surfaces were charred. The nylon covering was slightly fused.

(2) Test Group 40 - located 4600 ft from GZ.

The support received severe damage from the blast forces. The support collapsed with all mast sections receiving sufficient damage to require replacement. All guys, anchors, and hardware items remained intact and serviceable. The forward anchors were raised out of the ground from 6 in. to 18 in. from the pre-blast position. Two of the boom sections remained serviceable. The parabolic reflector was severely damaged, probably as a result of the mast collapsing. The dacron outrigger guys which faced towards the blast center failed. Painted surfaces, dacron outriggers, and the nylon covering of the steel guy wire rope facing the blast center received light thermal damage. Paint surfaces were charred. The dacron and the nylon covering were slightly fused.

(3) Test Group 49 - located 5550 ft from GZ.

The support received severe damage from the blast forces. The support collapsed above the first guy level. Five mast sections received sufficient damage to require replacement. Two of the mast sections and the three boom sections remained intact and serviceable as did all guys, anchors, and hardware items. The parabolic reflector was moderately damaged as a result of the mast collapse. Painted surfaces, dacron outriggers, and the nylon covering of the steel guy wire rope facing the blast center received light thermal damage. Paint surfaces were charred. The dacron and the nylon covering were slightly fused.

c. PHOTOGRAPHS: Pre- and postshot photographs of Test Groups 39, 40, and 49 are shown in Figs. 3.94, 3.95, and 3.104.

3.9.2 Mast AB-224/U -Test Groups 41 and 50, Shot 9 (Figs. 3.96 through 3.105)

a. DESIGN: At the top of each mast a three-section whip antenna was mounted to a non-flexible adaptor. The whip antenna consisted of one Mast Section MS-116, one Mast Section MS-117 and one Mast Section MS-118 with an assembled length of approximately 9 ft. The mast was oriented so that the blast forces would occur between two sets of guys. The mast and antenna were painted olive drab.

b. RESULTS:

(1) Test Group 41 - located 4625 ft from GZ.

Support was severely damaged by the blast forces. The mast buckled at the joint of the third section from the top. The mast remained upright up to the joint of buckling. Because of the construction it would be necessary to replace the entire unit. Light thermal

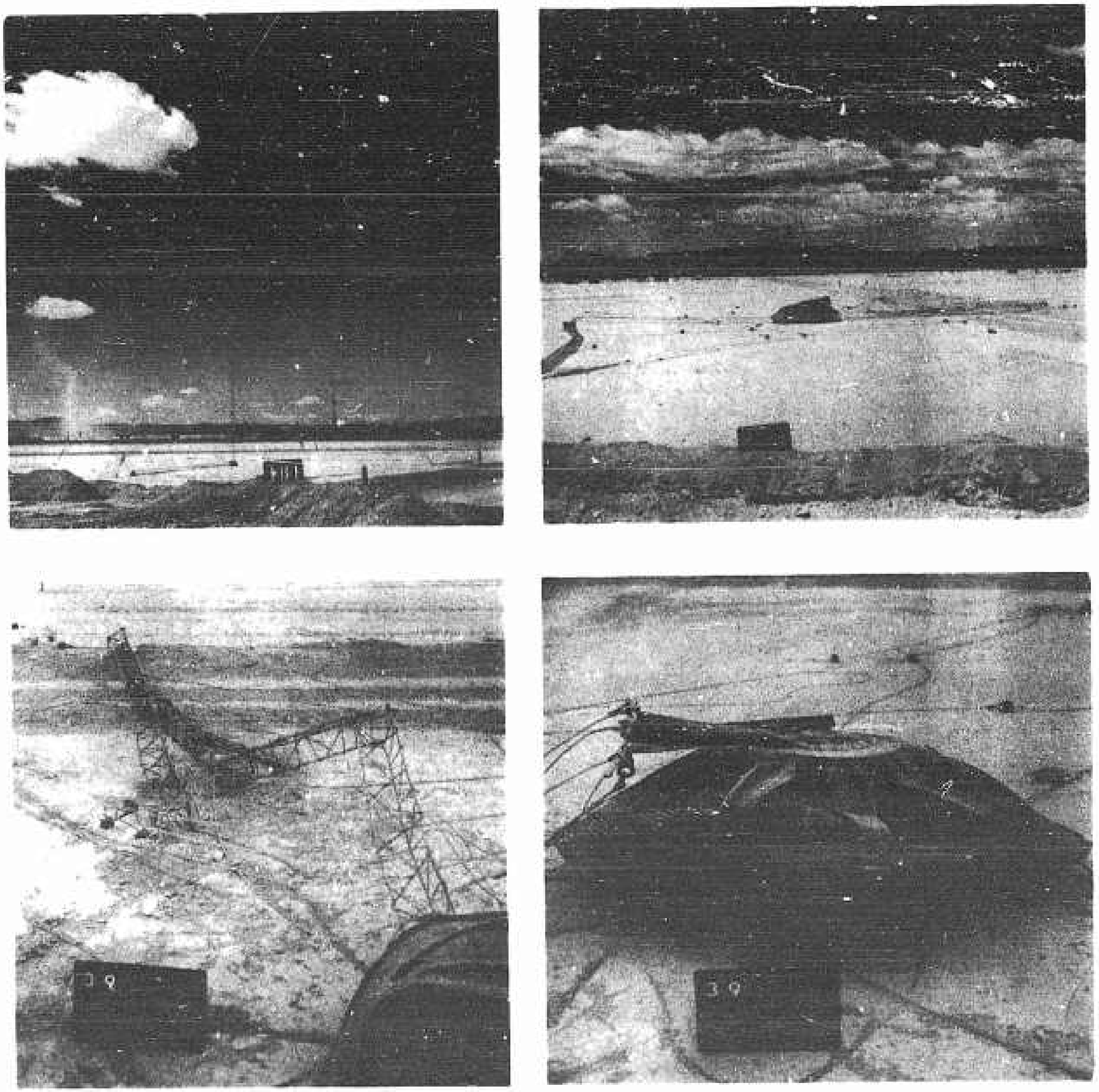


Fig. 3.94 Shot 9, Test Group 39, Antenna Mast AB-26/CR. (Top left-close-up, after; Bottom right-Reflector, after) 4050 ft, 40.5 cal, 8 psi.

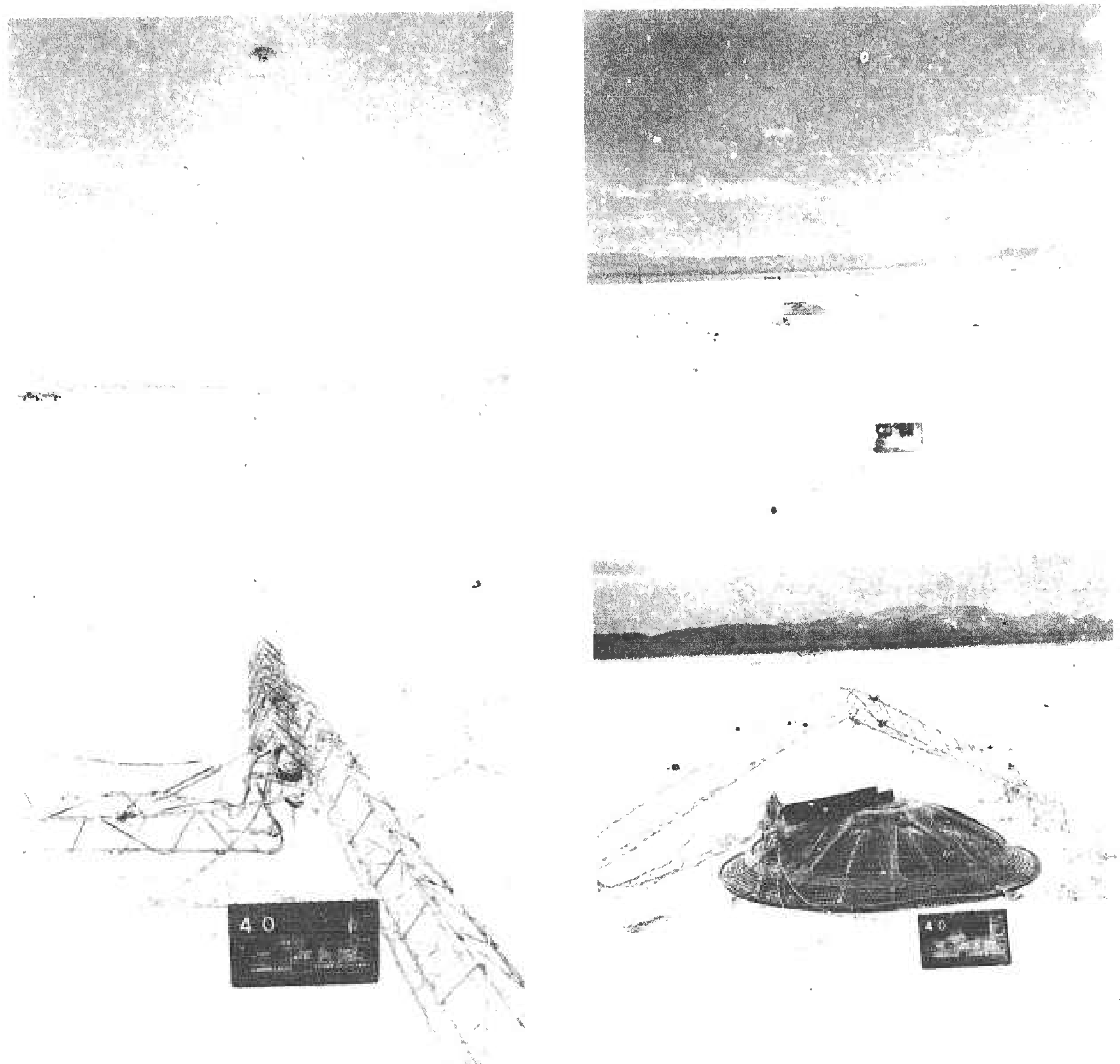


Fig. 3.95 Shot 9, Test Group 40, Antenna Mast AB-26/CR.
(Top Left-before, Top right-after, Bottom left-close-up, after, Bottom right-Reflector, after) 4600 ft, 32.5 cal, 6.8 psi.

damage to painted surfaces and nylon guy surfaces facing blast center. Guys, guy stakes, and hardware items remained intact and serviceable.

(2) Test Group 50 - located 5575 ft from GZ.

No damage by blast forces. Mast and antenna erect and intact. Very light damage by thermal forces. Slight fusing of the nylon guy surfaces facing the blast center. Slight charring of paint surfaces facing the blast center.

c. PHOTOGRAPHS: Pre- and postshot photographs of Test Groups 41 and 50 are shown in Figs. 3.96 and 3.105.

3.9.3 Antenna System AS-19( )/TRC-1 - Test Groups 42, 43, and 100, Shot 9 (Figs. 3.97, 3.98, and 3.110)

a. DESIGN: For each installation the antenna was oriented normal to GZ, and the mast was oriented to receive the blast forces between the guys. The masts were painted olive drab. A damage summary of these test groups is shown in Table 3.16.

b. RESULTS:

(1) Test Group 42 - located 4650 ft from GZ.

The antenna system received severe damage from the blast forces. The antenna support collapsed. The antenna array was separated from the support as a result of the support collapse and broke into several parts. The coaxial cable tore from the cable connector at the upper end. All mast sections were bent. The mast base pulled out from the ground, severely bending the base plate. The two top forward guys and the bottom forward guy failed at the mast end. Antenna system received moderate damage from the thermal forces. That portion of the surfaces exposed to the blast center of antenna insulators, the fiberglass mast section, the rubber covered coaxial cable, the friction tape, and painted steel mast sections were charred but remained serviceable. Th friction tape was used to secure the coaxial cable to the mast at regular intervals for the entire height.

(2) Test Group 43 - located 4900 ft from GZ.

The antenna system received severe damage from the blast forces. The antenna support collapsed. The two top forward nylon guys failed. The top steel mast section, the fiberglass mast section, and the antenna array were separated from the mast. The antenna array was severely damaged by the fall. Three of the elements were broken at the base fitting. The mast section below the first guy level buckled and the four sections above were bent. The coaxial cable was torn free of the cable connector at the upper end. Many of the mast components could be reused. The antenna system received moderate to light thermal damage on the surfaces of all parts facing the blast center. The painted mast sections were slightly charred. The nylon guys, antenna insulators, fiberglass mast section, rubber covered coaxial cable, and the friction tape used to secure the coaxial cable to the masts, were charred but remained serviceable.

(3) Test Group 100 - located 6350 ft from GZ.

The antenna system received severe damage from the blast forces. The antenna support collapsed. There were no guy failures. The antenna remained attached to the mast. Three of the antenna elements were broken as a result of the fall. The mast base

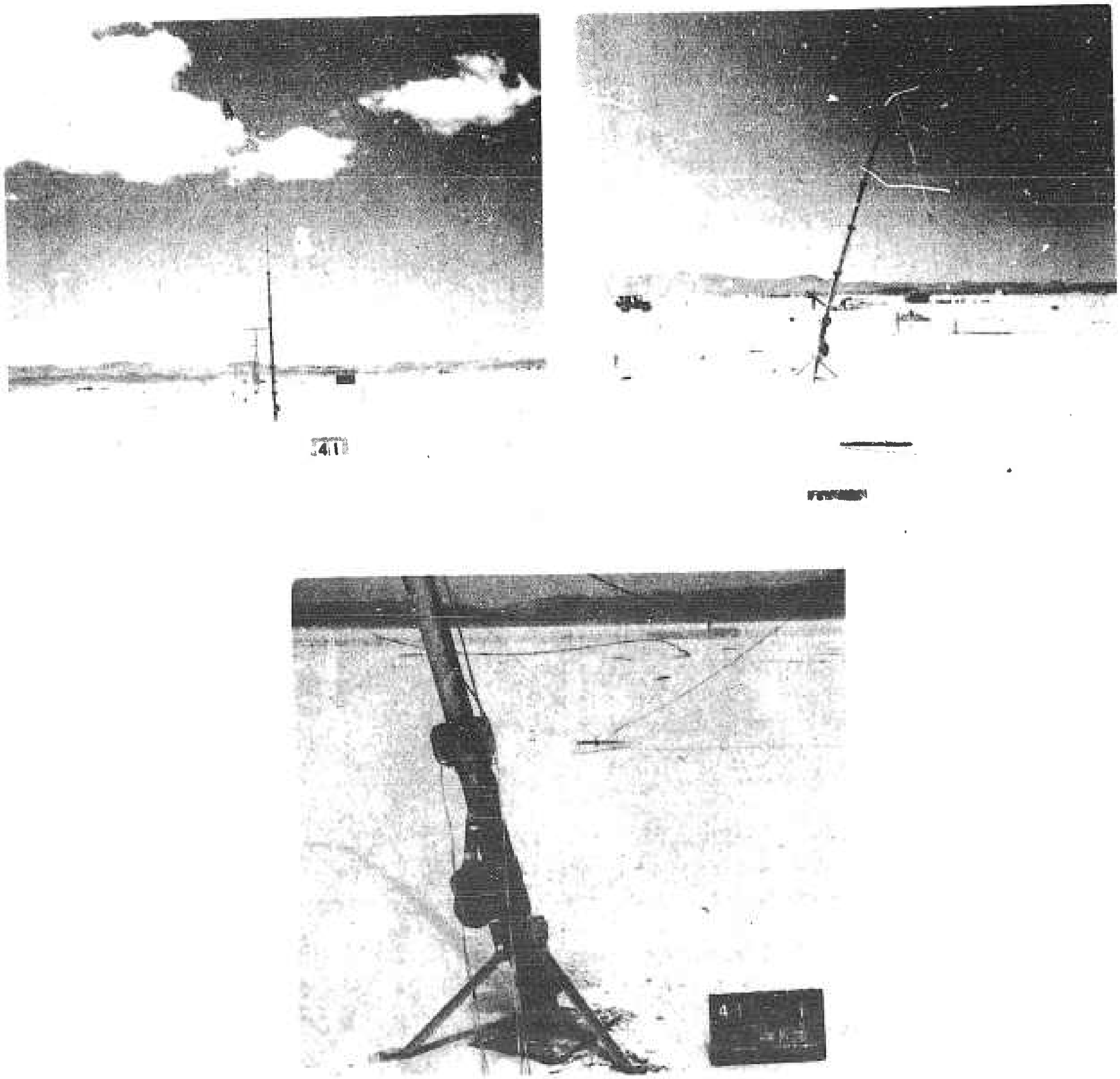


Fig. 3.96 Shot 9, Test Group 41, Antenna Mast AB-224/U. (Top Left-before, Top right-after; Center Close-up of Antenna Base-after) 4625 ft, 32.5 cal, 6.8 psi.

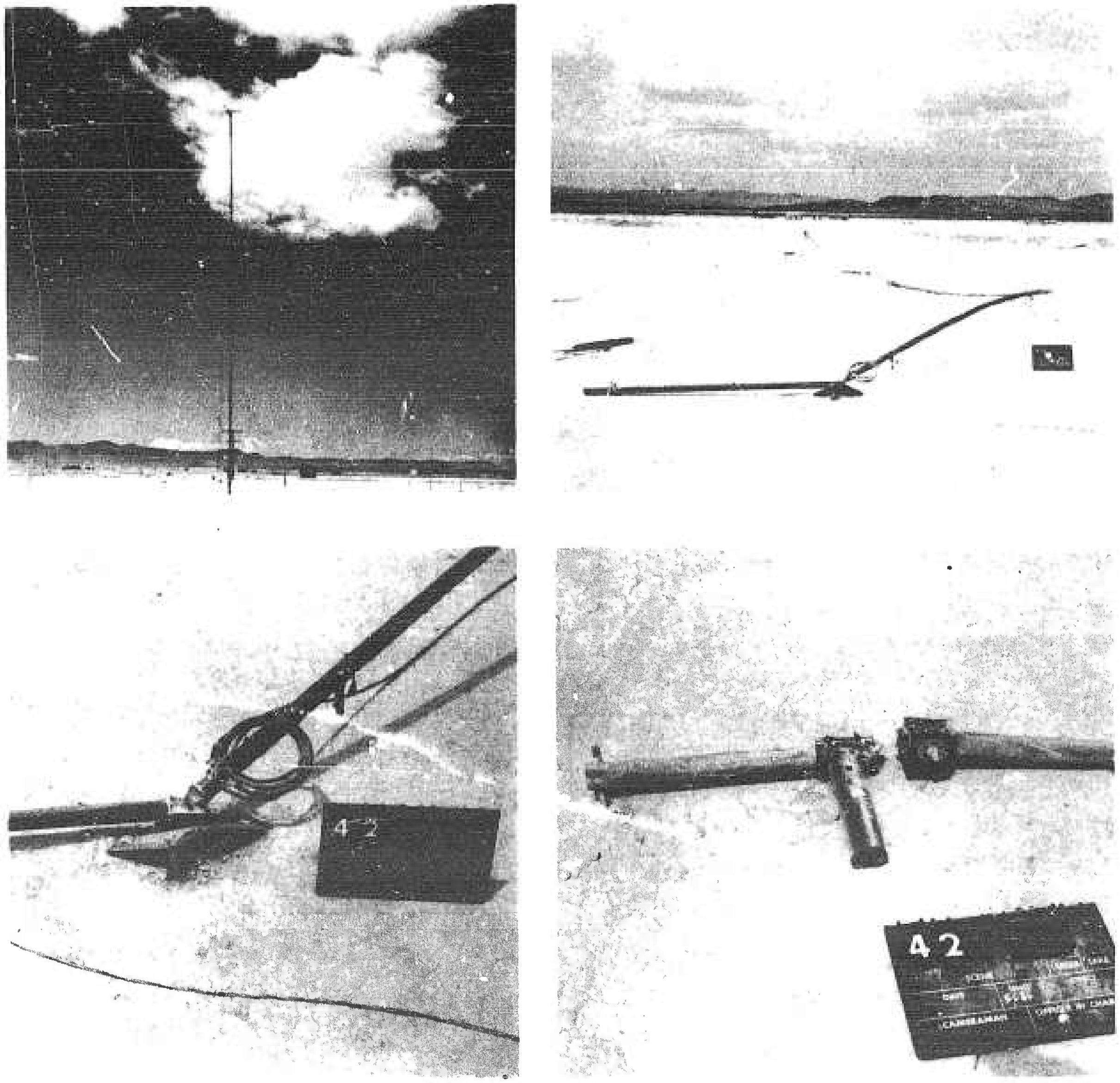


Fig. 3.97 Shot 9, Test Group 42, Antenna System AS-19/TRC-1. (Top left-before, Top right-after; Bottom left, Antenna Base-after; Bottom Right, View of Break at Top of Mast-after.) 4650 ft, 32.5 cal, 6.8 psi.

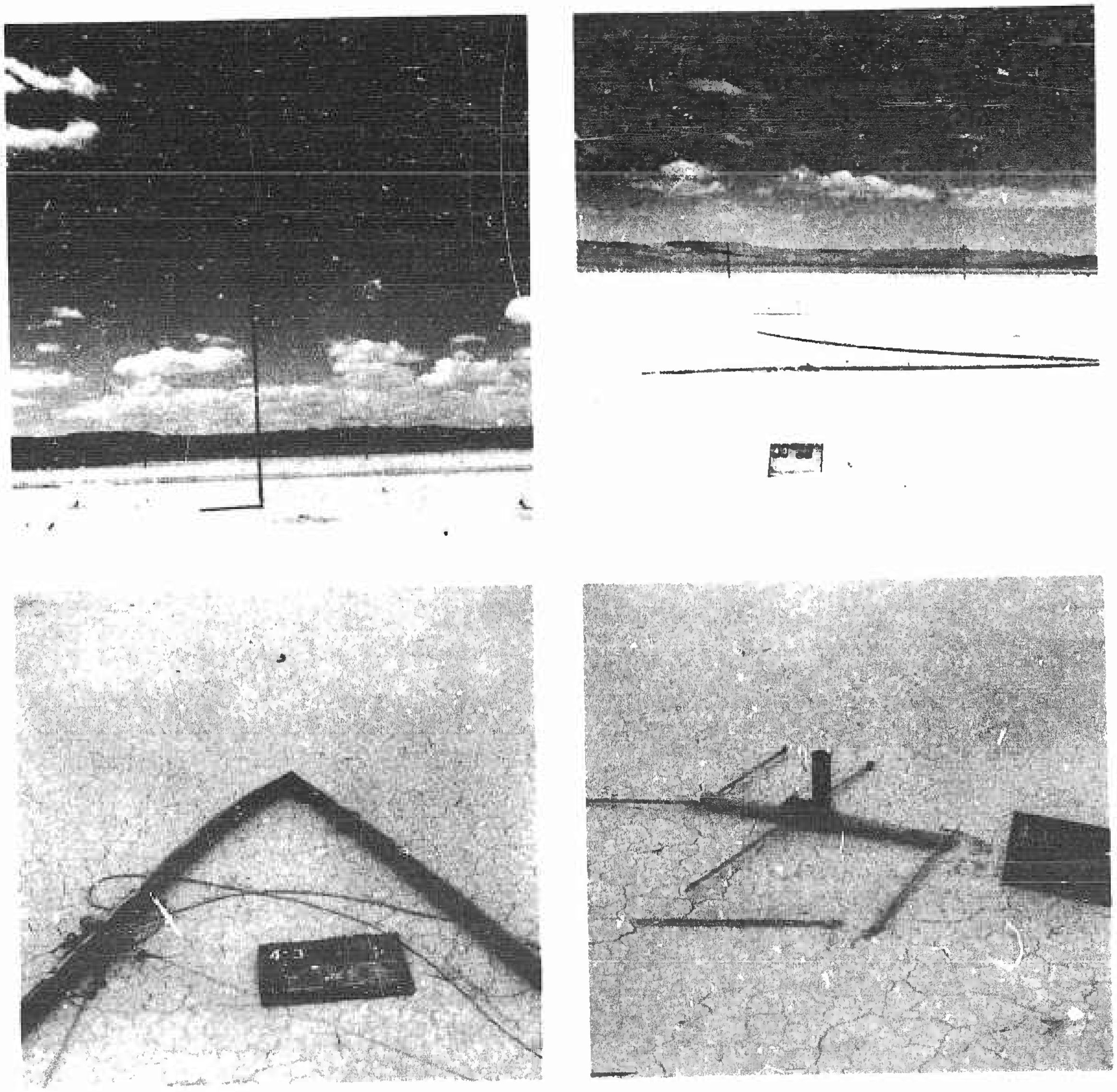


Fig. 3.98 Shot 9, Test Group 43, Antenna System, AS-19/TRC-1. (Top left-before, Top right-after, Bottom left, bent Mast-after, Bottom Right-Broken Top of Mast) 4900 ft, 29.5 cal, 6.2 psi.

was severely damaged. The second mast section, below the first guy level, buckled. The first section above and the first section below the buckled section were bent. Guys, stakes and hardware items remained intact and serviceable. The antenna system received light thermal damage on the surfaces of all parts facing the blast center. The nylon guys showed slight evidence of fusing. The plastics used were slightly charred. The rubber covered coaxial cable and the friction tape used to secure it to the mast showed slight evidence of charring.

c. PHOTOGRAPHS: Pre- and postshot photographs of Test Groups 42, 43, and 100 are shown in Figs. 3.97, 3.98, and 3.110.

3.9.4 Mast AB-155/U - Test Groups 44, 52, and 54, Shot 9 (Figs. 3.99, 3.107, and 3.109)

a. DESIGN: Each test group consists of two masts with a 50 ft length of copper antenna wire strung between, oriented so that the antenna was normal to GZ. The masts were oriented so that the blast forces occurred between two sets of guys. A damage summary of these test groups is shown in Table 3.16.

b. RESULTS:

(1) Test Group 44 - located 4900 ft from GZ.

The antenna system received severe damage from the blast forces. Both masts collapsed. One halyard pulley failed. Several guy insulators were broken. One snap which secured a set of three forward guys failed, releasing all three of the guys. All forward stakes either pulled out or were loose and about one-half out of the ground. Light thermal damage to the antenna system on those surfaces of masts and guys which faced the blast center. Paint slightly charred. Nylon guys partially fused.

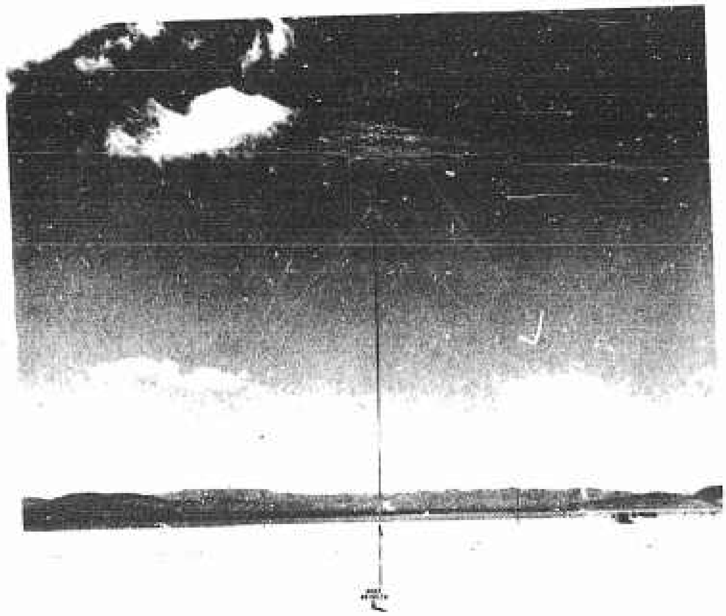
(2) Test Group 52 - located 5625 ft from GZ.

The antenna system received severe damage from the blast forces. Both masts collapsed. One forward guy failed. Each mast had one stake nearest the blast center pull out of the ground. One of the stakes pulled out completely, the other was raised three inches. All but one of the guys remained intact and reusable. All hardware reusable. Light thermal damage to the antenna system on those surfaces of masts and guys which faced the blast center. Paint on mast sections slightly charred. Nylon guy ropes showed slight evidence of fusing.

(3) Test Group 54 - located 5675 ft from GZ.

The antenna system received severe damage from the blast forces. Both masts collapsed. Each mast had one forward stake pull out of the ground. One of the stakes pulled out completely, the other was raised three inches. All guys and hardware items remained intact and serviceable. Very light thermal damage to the antenna system on surfaces of masts and guys which faced the blast center. Traces of paint charring on the mast sections. Dacron guy ropes showed less evidence of fusing than the nylon ropes at the same distance from the blast center.

c. PHOTOGRAPHS: Pre- and postshot photographs of Test Groups 44, 52, and 54 are shown in Figs. 3.99, 3.107, and 3.109.



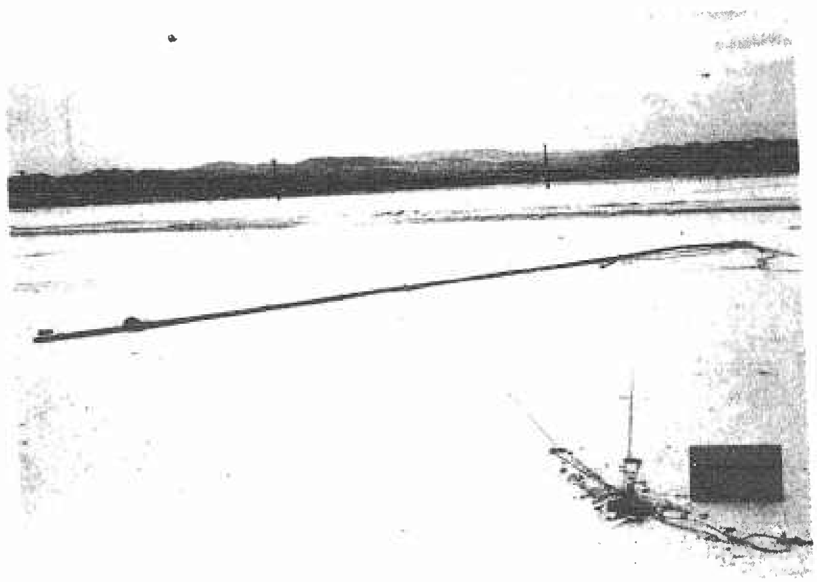


Fig. 3.99 Shot 9, Test Group 44, Antenna Mast AB-155/U.
(Top-before, Bottom-after)
4900 ft, 29.5 cal, 6.2 psi.

3.9.5 Lightweight Masts - Test Groups 45, 46, 51, and 53, Shot 9 (Figs. 3.100, 3.101, 3.106, and 3.108

a. DESIGN: The masts were oriented so that the blast forces would occur between two sets of guys. A damage summary of these test groups is shown in Table 3.16.

(1) Test Group No. 45 - The mast was made up of twelve 1-1/2 in. square x 30 in. long magnesium tubular sections using dacron guys.

(2) Test Group No. 46 - The mast was made up of fourteen 1-1/2 in. diameter x 26 in. long fiberglass tubular sections with tapered ends using nylon guys.

(3) Test Group No. 51 - The mast was made up of twelve 1-1/2 in. diameter x 30 in. long magnesium tubular sections with an enlarged swaged joint at one end using nylon guys.

(4) Test Group No. 53 - The mast was made up of twelve 1-5/8 in. diameter x 30 in. long convolute wound fiberglass tubular sections with coupling joints using dacron guys.

b. RESULTS:

(1) Test Group 45 - located 4925 ft from GZ. The mast received severe damage from the blast forces. Collapse of the mast may have been caused by failure of the forward guy snap retainers on the guy plates. The mast sections were separated and scattered, some as far as 200 ft away. The antenna array was severely damaged. The mast sections and guys remained serviceable. Light thermal damage to dacron guy surfaces which faced the blast center. Fusing of the dacron was somewhat less than for the nylon guys at the same distance from the blast center.

(2) Test Group 46 - located 4950 ft from GZ. Severe blast damage to mast and antenna array. The mast collapsed and as a result three of the antenna elements were broken. Three of the mast sections were broken at joints. Guy snap retainers, on the guy plates at all three guy levels for the forward guys, failed, releasing the guys. Light thermal damage to the nylon guy surfaces which faced the blast center. The nylon guys showed slight evidence of fusing.

(3) Test Group 51 - located 5550 ft from GZ. Moderate damage by blast forces to the mast. The mast did not collapse. The antenna array was undamaged. Guy snap retainers on guys in the plates of the lower and middle forward guys failed, releasing both guys. The installation remained serviceable, requiring approximately one-half hour to repair.

(4) Test Group 53 - located 5575 ft from GZ. Severe blast damage to the mast and antenna array. Damage to the antenna array was due to the mast collapse. Two antenna elements were broken. Three of the mast sections failed at joints. Guy snap retainers, on the guy plates at all three guy levels for the forward guys failed, releasing the guys. Dacron guys received light thermal damage evidencing slight fusing of the surfaces which faced the blast center. Fusing was less than for the nylon guys at the same distance from the blast center.

c. PHOTOGRAPHS: Pre- and postshot photographs of Test Groups 45, 46, 51, and 55 are shown in Figs. 3.100, 3.101, 3.106, and 3.108.

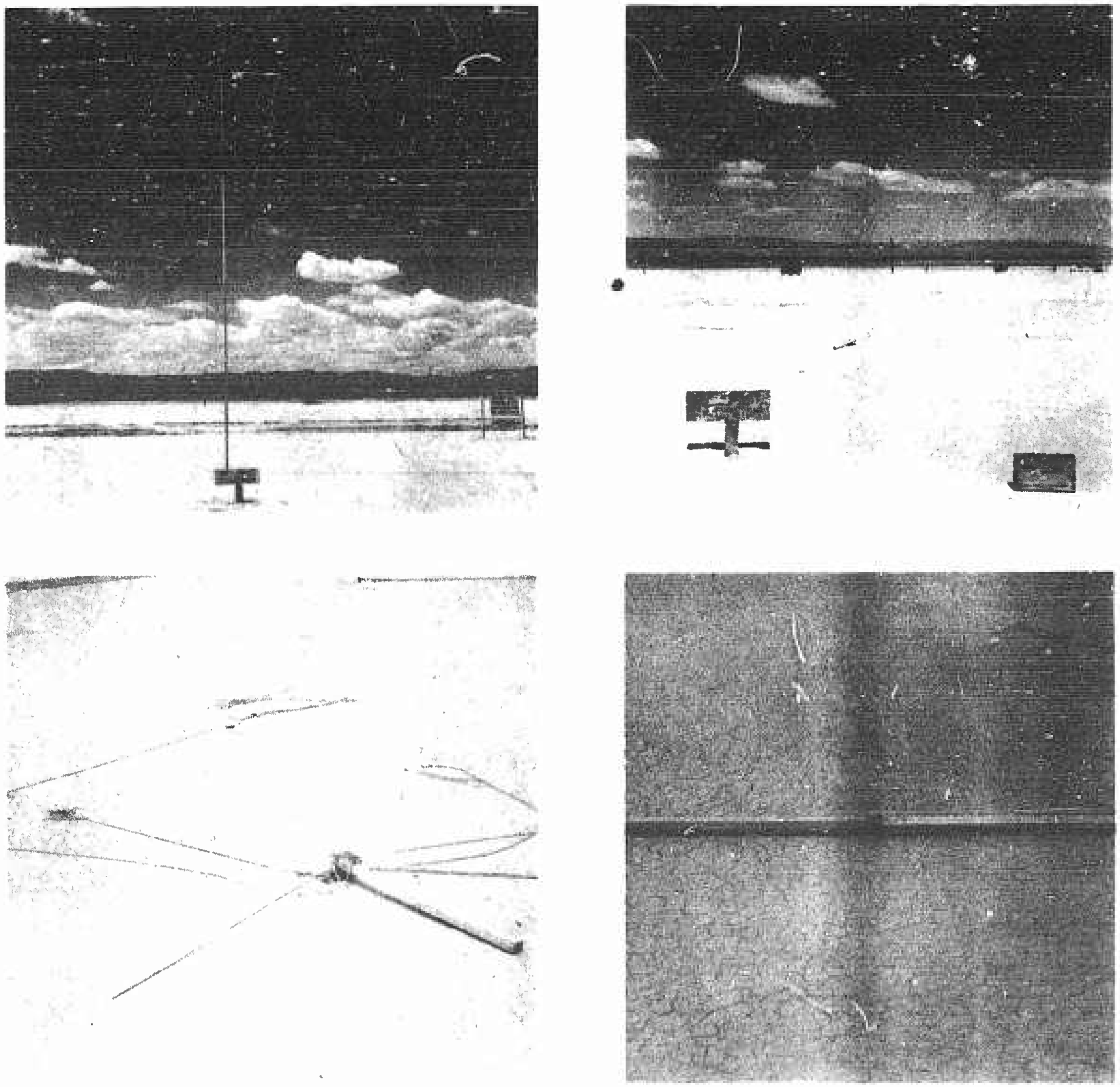


Fig. 3.100 Shot 9, Test Group 45, Magnesium Mast, 30 ft. (Top left-before, Top right-after; Bottom left, Top of Mast-after; Bottom right, Broken Mast Joints-after.) 4925 ft, 29.5 cal, 6.2 psi.

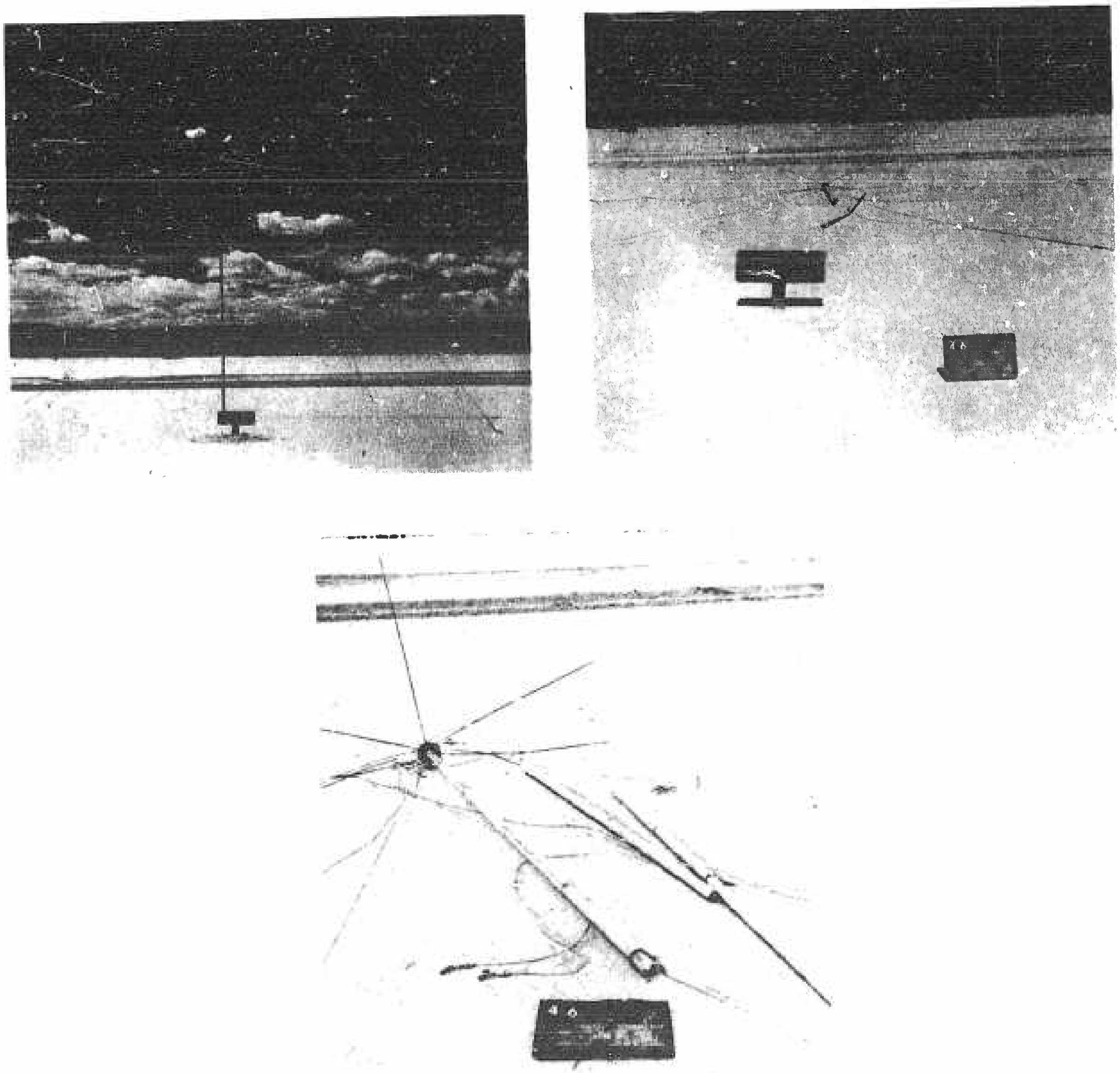


Fig. 3.101 Shot 9, Test Group 46, Magnesium Mast, 30 ft. (Top left-before, Top right-after; Bottom, Broken Mast Sections-after) 4950 ft, 29.5 cal. 6.2 psi.

3.9.6 Antenna Group - AN/GRA-4, Test Groups 47 and 48, Shot 9 (Figs. 3.102 and 3.103)

a. DESIGN: The antenna was strung between the two masts which were erected 50 ft apart. The masts were oriented so that the antenna was normal to GZ and the blast forces occurred between two sets of guys on each mast. A damage summary of these test groups is shown in Table 3.16.

b. RESULTS:

(1) Test Group 47 - located 5000 ft from GZ. The antenna system received severe damage from the blast forces. Both masts collapsed. Several guys failed on both mast installations. Stakes remained in position. The fiberglass base insulators were undamaged by blast or thermal forces. Light thermal damage to the dacron guy surfaces which faced the blast center. Fusing on guy surfaces less than for the nylon guys at same distance from the blast center. The masts were not serviceable.

(2) Test Group 48 - located 5000 ft from GZ. The antenna system received severe damage from the blast forces. Both masts collapsed. All guys, guy stakes, hardware items, and the antenna remained intact and reusable. The fiberglass base insulators were undamaged by the blast forces or the thermal radiation. Antenna system was not serviceable. Light thermal damage to the nylon guy surfaces which faced the blast center. Slight fusing was more than for the dacron guys at the same distance from the blast center.

c. PHOTOGRAPHS: Pre- and postshot photographs of Test Groups 47 and 48 are shown in Figs. 3.102 and 3.103.

3.10 RADIO SETS TEST GROUPS 55 - 58, 80 - 82, SHOT 9 (FIGS. 3.111 - 3.124)

a. DESIGN: Radio Sets AN/GRC-26 with K-52 trailers were placed in sandbagged revetments 4 ft deep, at 1700, 3500, 4500, and 5500 ft from GZ. The S-56 Shelters were oriented with the doors facing the blast. The shelter at 1700 ft was protected on the top by 24 in. of earth cover. Shelters at 3500, 4500, and 5500 ft from GZ were protected on the top by 12 in. of earth cover. All doors were closed at the time of the blast. The K-52 trailers containing PE-95 Power Units were placed in 5 ft deep trenches with open inclines at either end. All trenches were oriented radial to the blast with one exception. The trench at 3500 ft from GZ was normal to the blast.

(1) Test Group 80 consisted of an AN/GRC-9 Radio placed in an Ordnance Corps 1/4 ton Jeep. (Test Group 80 also included an S-56 Shelter mounted in an Ordnance Corps 2-1/2 ton truck. This shelter was sandbagged to the equipment weight of AN/GRC-26 equipment.) This test group was located at 1650 ft from GZ.

(2) Test Group 81 consisted of an AN/GRC-9 Radio Set mounted in an Ordnance Corps 1/4 ton 4 x 4 truck and an AN/GRC-26 Radio Set mounted in an Ordnance Corps 2-1/2 ton truck. This test group was located 2425 ft from GZ.

(3) Test Group 82 consisted of an AN/GRC-9 Radio Set mounted in an Ordnance Corps 1/4 ton Jeep (Test Group 82 also included

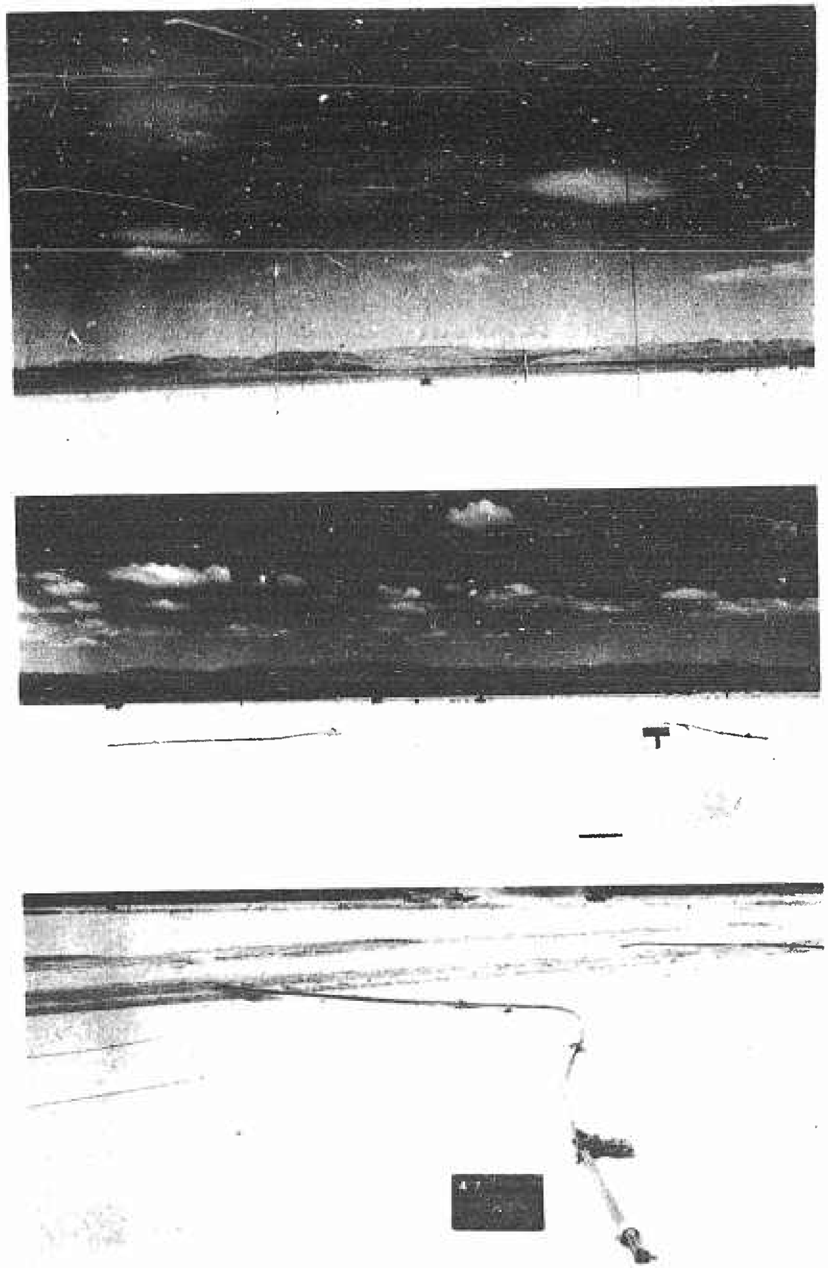


Fig. 3.102 Shot 9, Test Group 47, Antenna System AN-GRA-4.
(Top-before, Center-after, Bottom-after)
5000 ft, 28.5 cal, 6 psi.

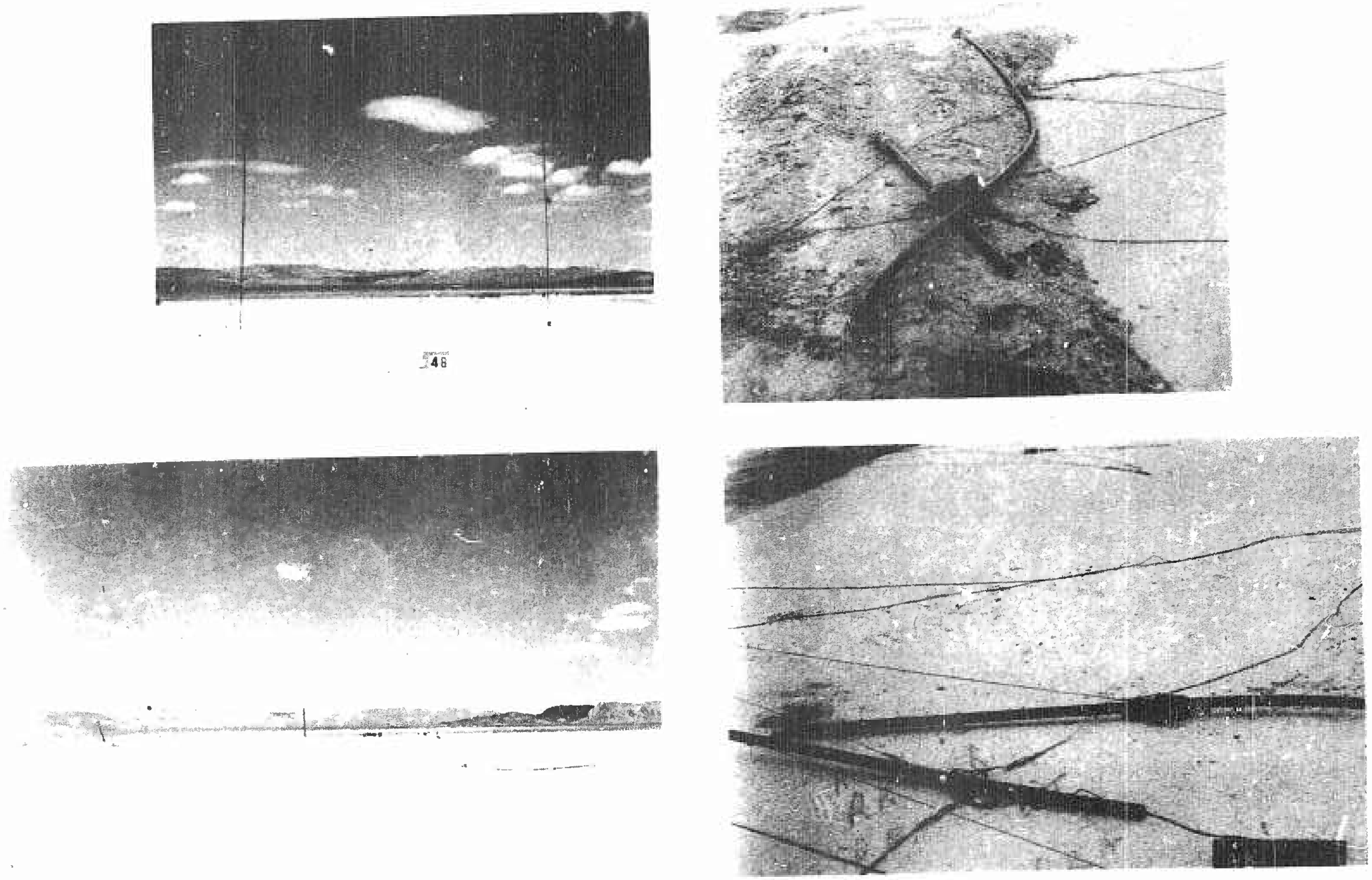


Fig. 3.103 Shot 9, Test Group 48, Antenna System AN/GRA-4. (Top left-before, Top right-after, Bottom left-after, Bottom right-after.) 5000 ft, 28.5 cal, 6 psi.

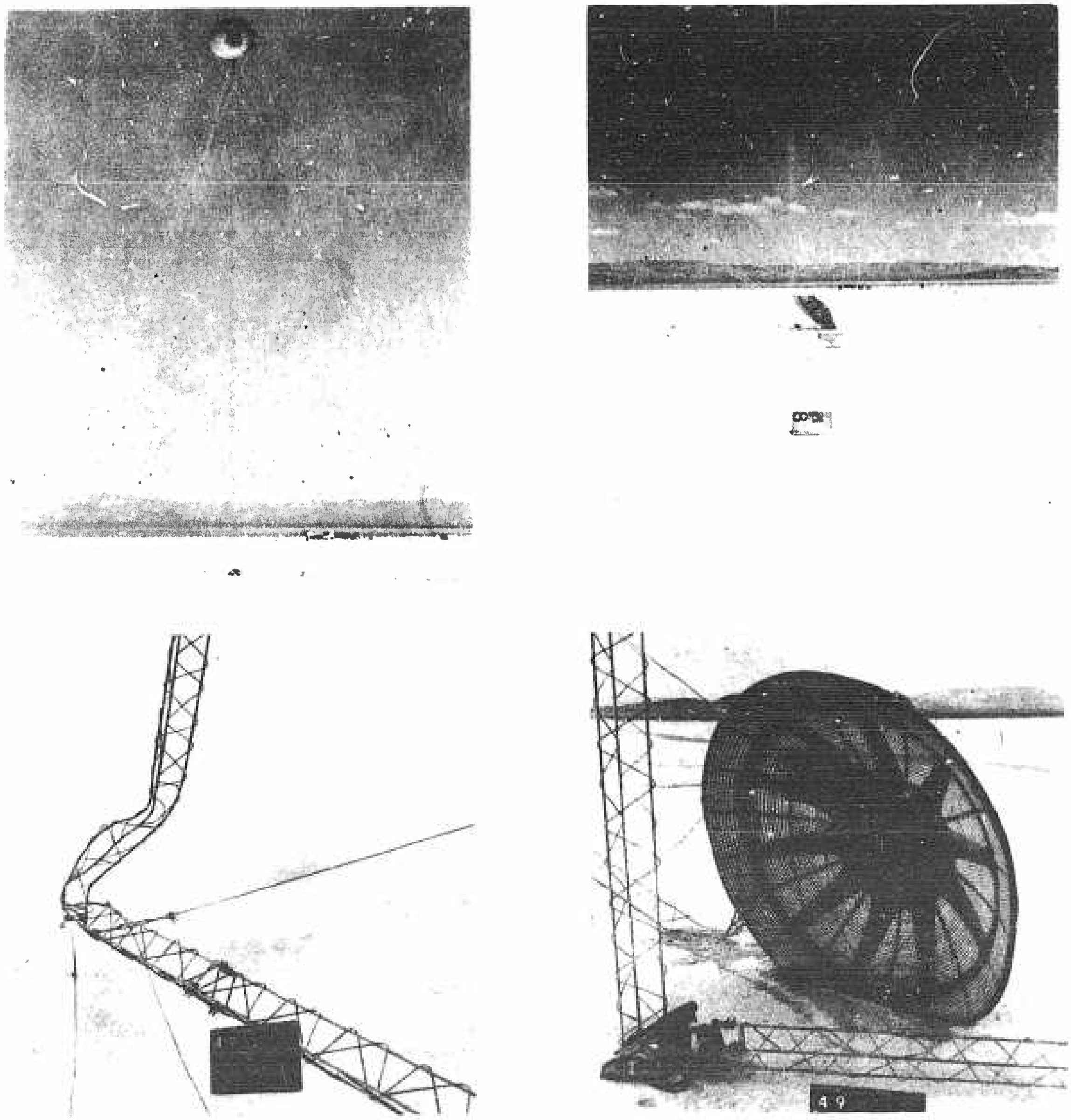


Fig. 3.104 Shot 9, Test Group 49, Antenna Mast AB-26/CR. (Top left-before, Top right-after; Bottom left, Section of Twisted and Broken Mast-after; Bottom right, Reflector-after.) 5550 ft, 25 cal, 5.4 psi.

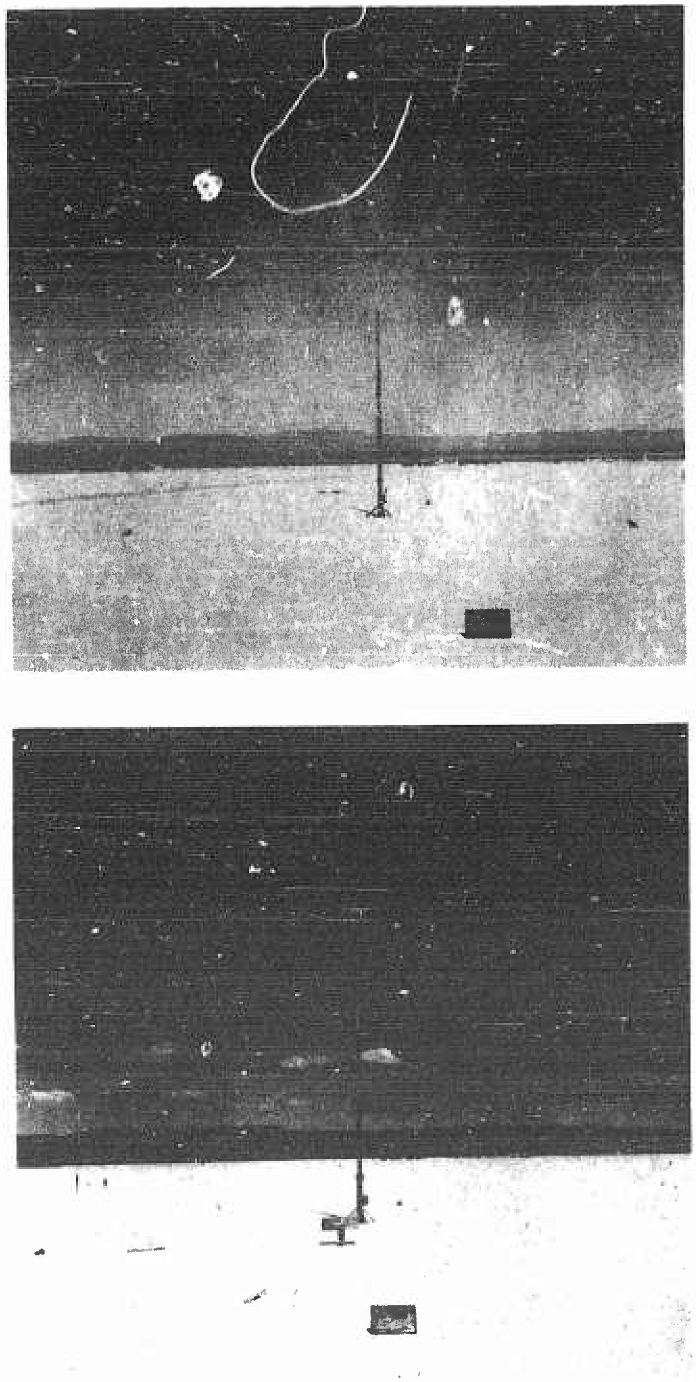


Fig. 3.105 Shot 9, Test Group 50, Antenna Mast AB-224/U. (Top-before, Bottom-after) 5575 ft, 25 cal, 5.4 psi.

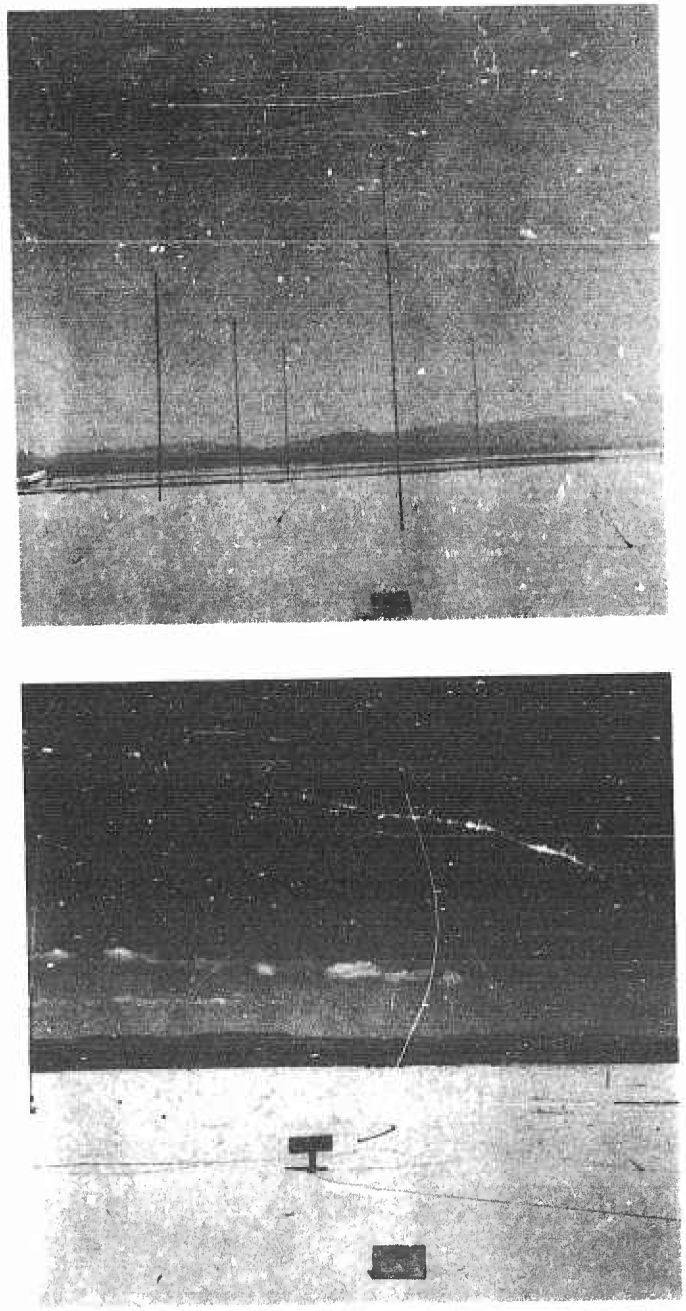


Fig. 3.106 Shot 9, Test Group 51, Antenna mast Magnesium.
(Top-before, Bottom-after)
5550 ft, 25 cal, 5.4 psi.

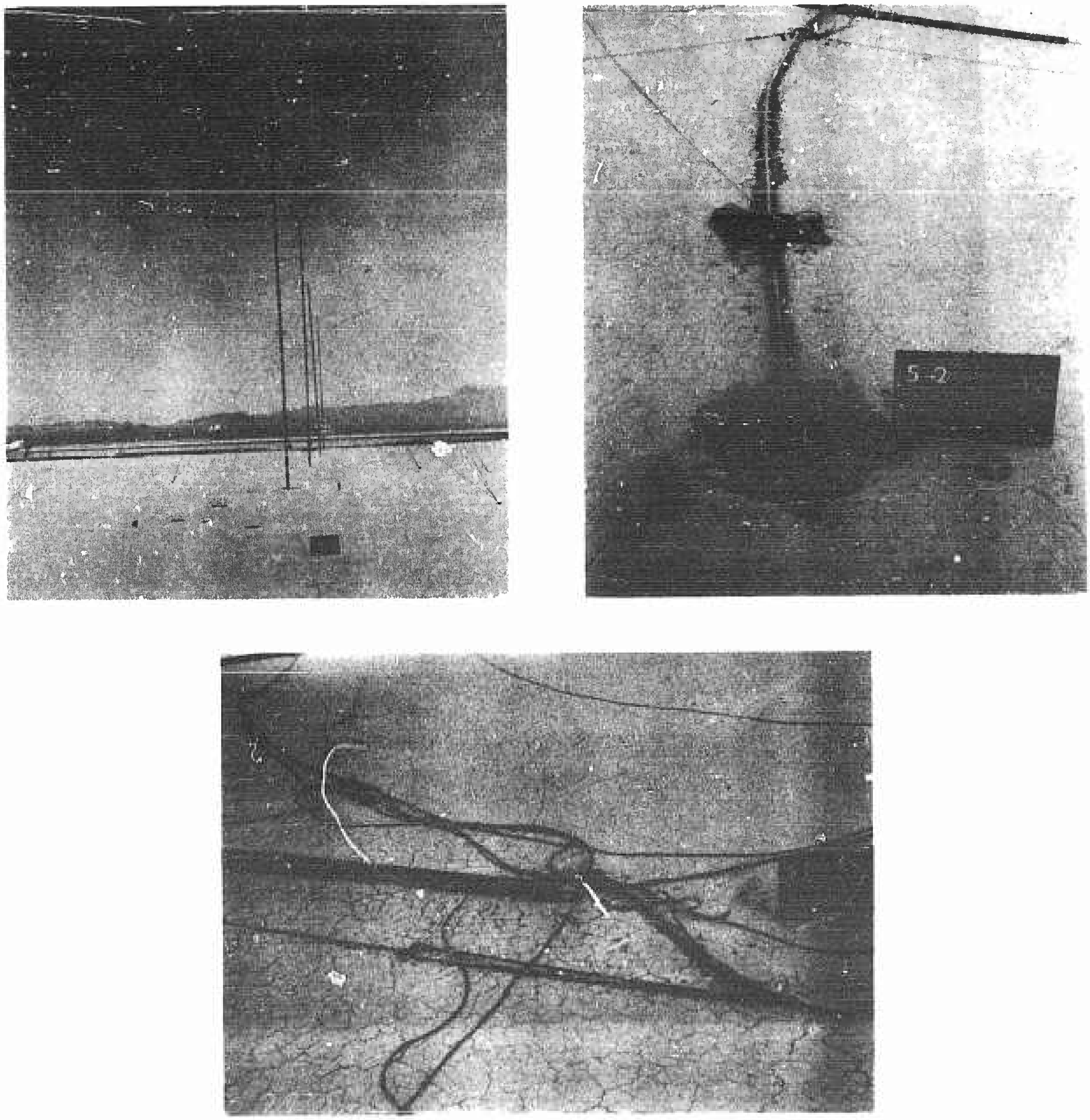


Fig. 3.107 Shot 9, Test Group 52, Antenna Mast AB-155/U. (Top left-before, Test Group 52 in Foreground, Top right-after, Bottom-after) 5625 ft, 24.5 cal, 5.3 psi.

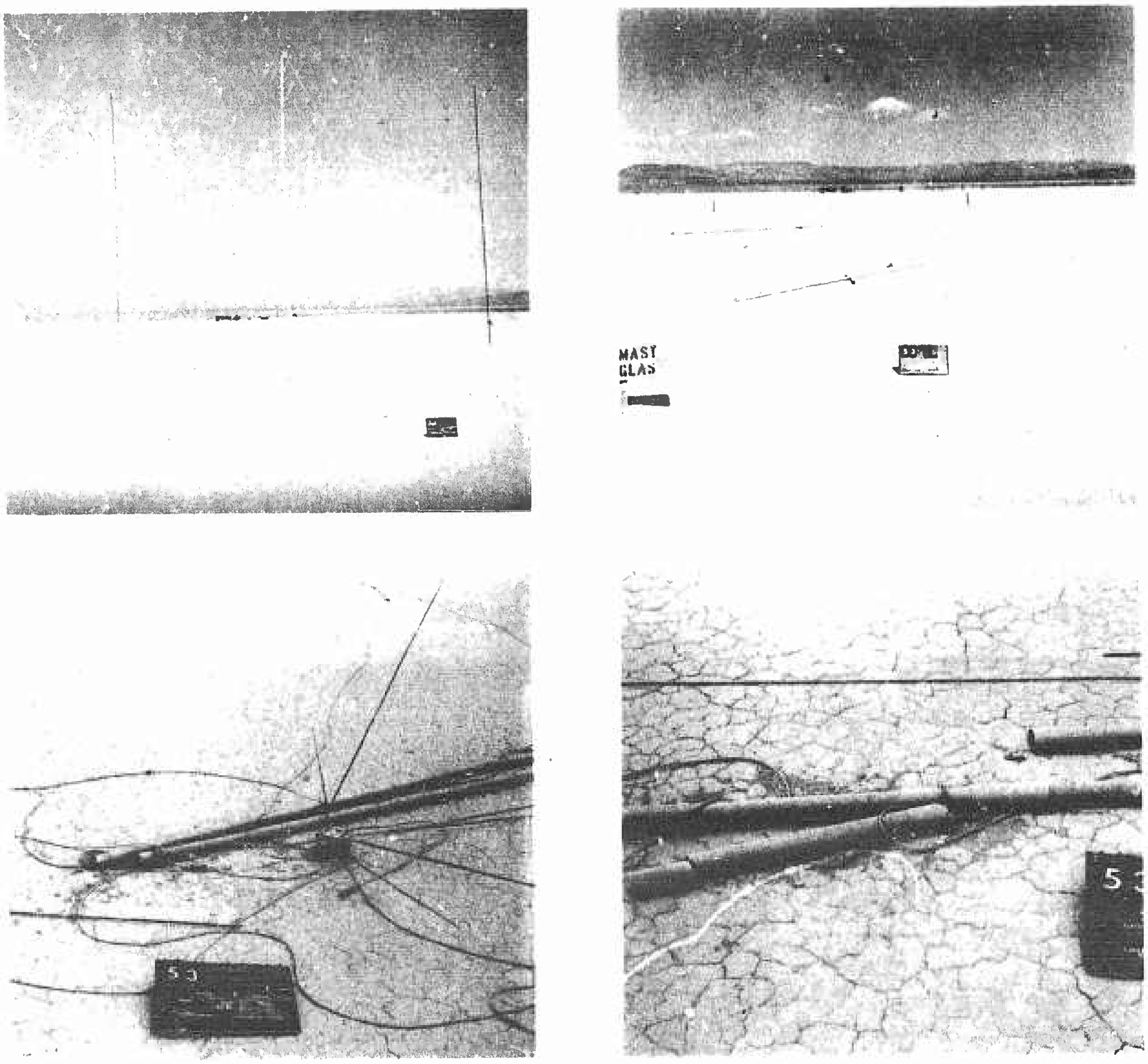


Fig. 3.108 Shot 9, Test Group 53, Antenna Mast, 30 ft, Fiberglass. (Top left-before, Top right-after; Bottom left, Broken Top-after, Bottom right, Broken Mast Section-after.) 5575 ft, 24.5 cal, 5.4 psi.

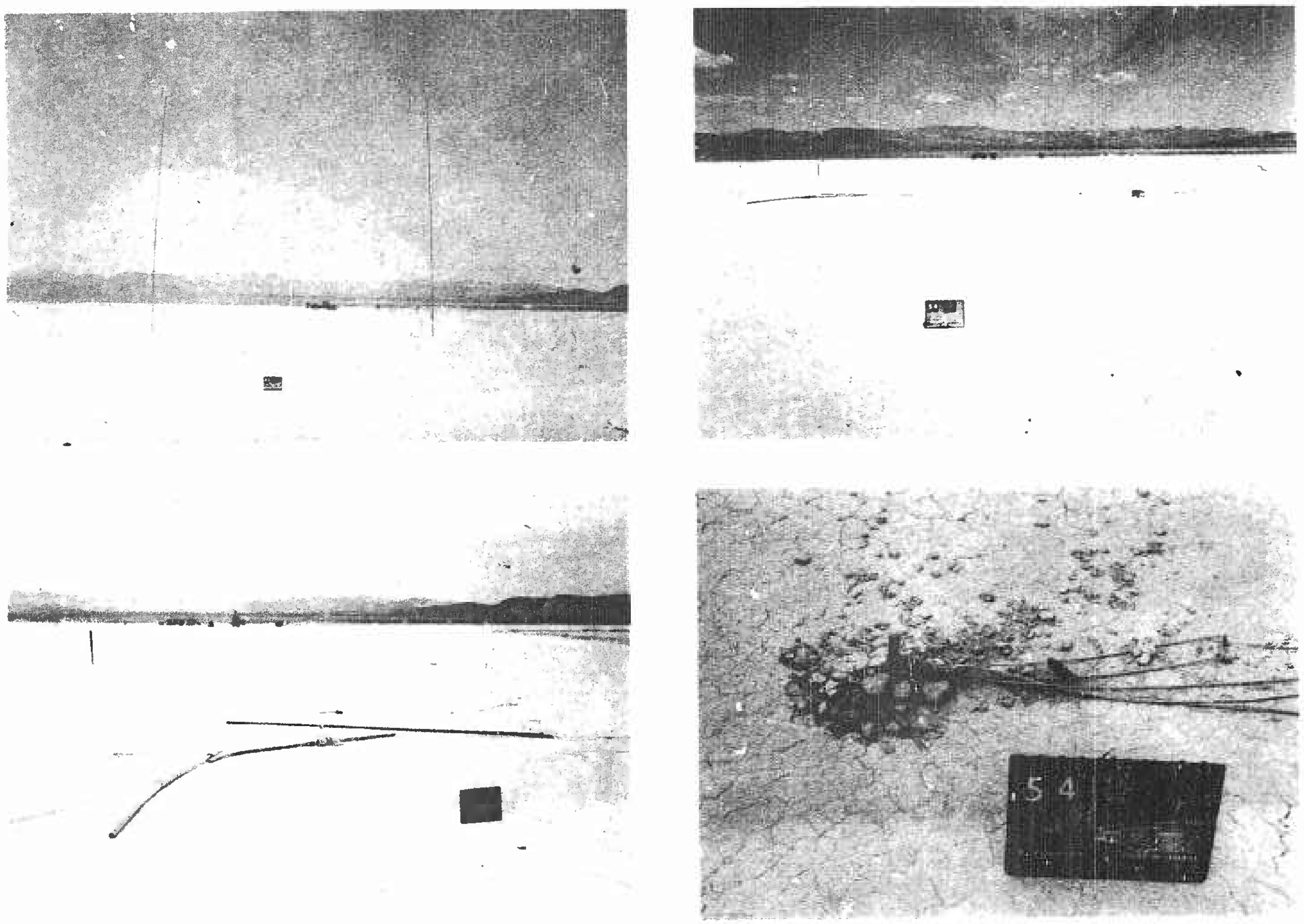


Fig. 3.109 Shot 9, Test Group 54, Antenna Mast AB-155/U. (Top left-before, Top right-after, Bottom right, Guy and Anchor-after.) 5675 ft, 24 cal, 4.6 psi.

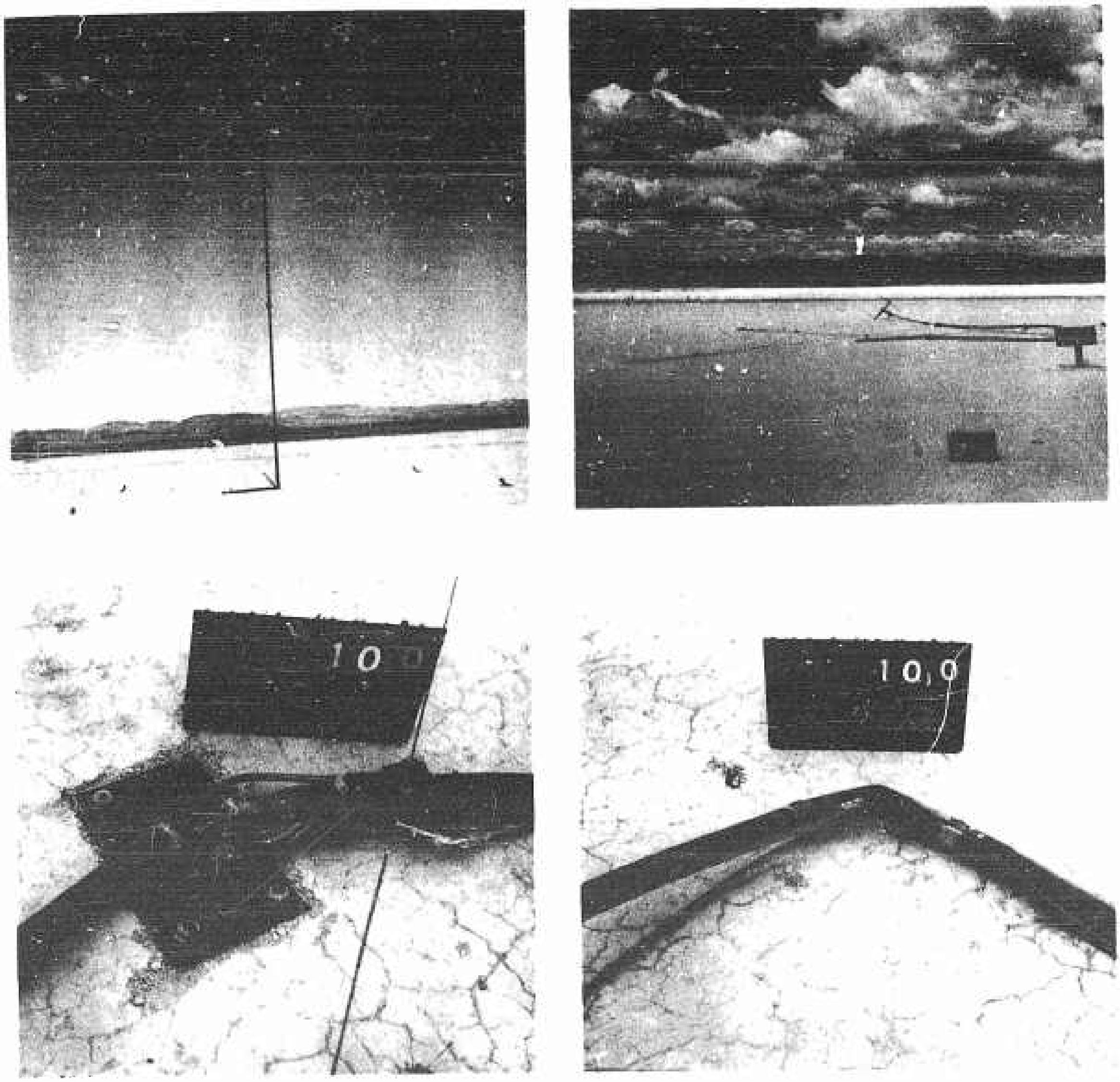


Fig. 3.110 Shot 9, Test Group 100, Antenna System AS-19/TRC-1. (Top left-before, Top right-after; Bottom left, Antenna base-after; Bottom right, Bent Mast Section-after.) 6350 ft, 19.5 cal, 4.6 psi.

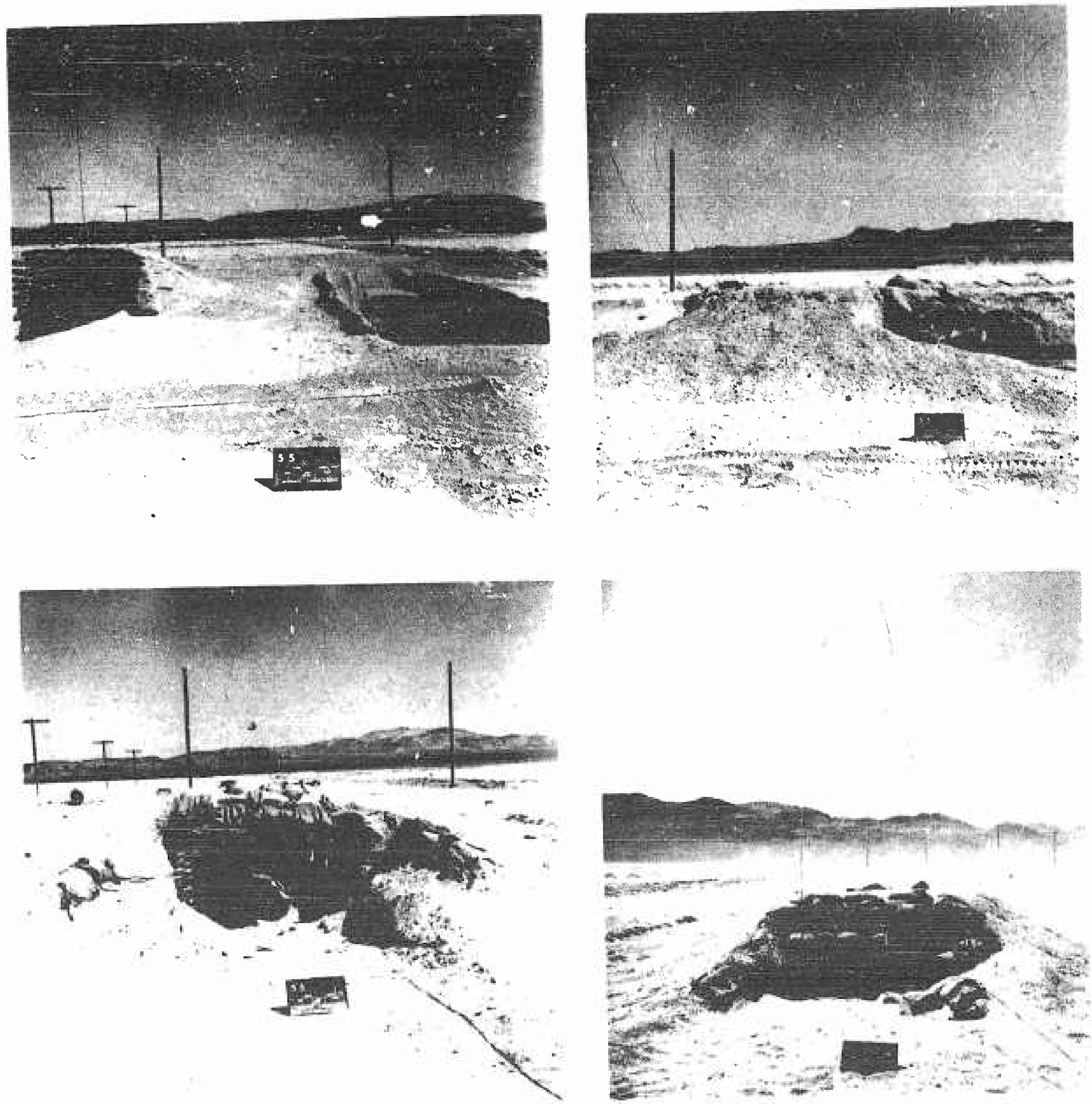


Fig. 3.111 Shot 9, Test Group 55, AN/GRC-26 Radio Set (Revetted). (Top left-before, Bottom left-after, Top right, Side View-after, Bottom right, Rear View-after.) 1700 ft, 91 cal, 13.8 psi, 3600 r at Surface, 572 r in S-56 Shelter.

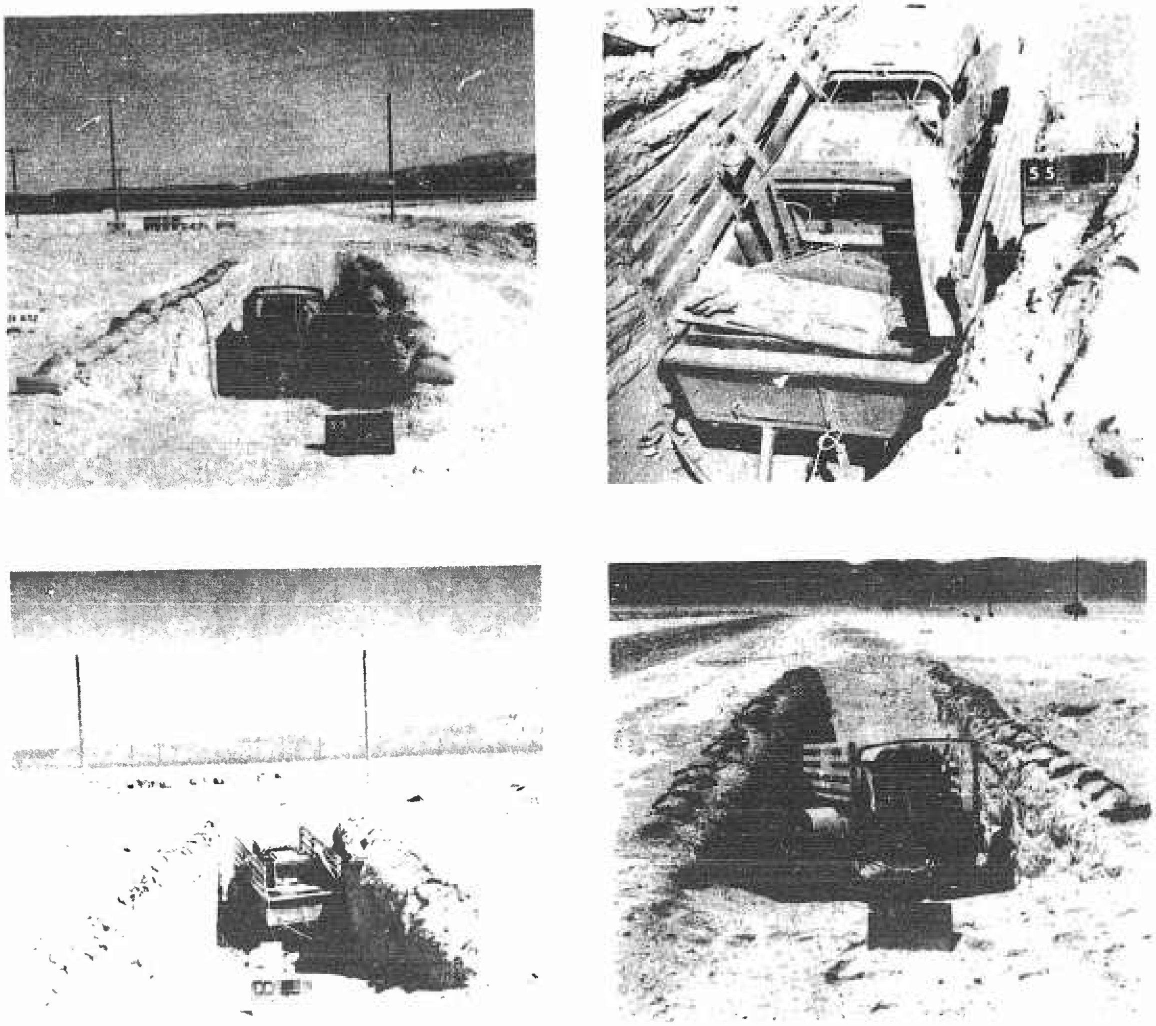


Fig. 3.112 Shot 9, Test Group 55, PE-95 Power Unit, Part of AN/GRC-26 Radio Set. (Top left-before, Bottom left-after, Top right, Front View-after, Bottom right, Rear View-after.) 1700 ft, 91 cal, 13.8 psi.

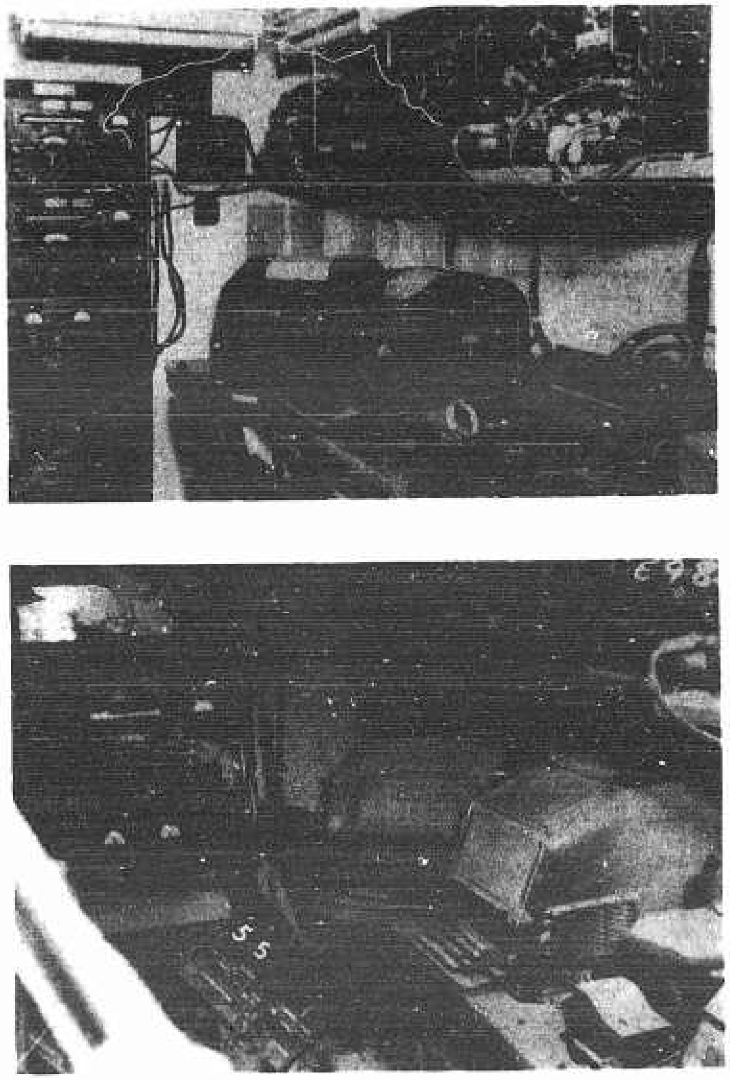
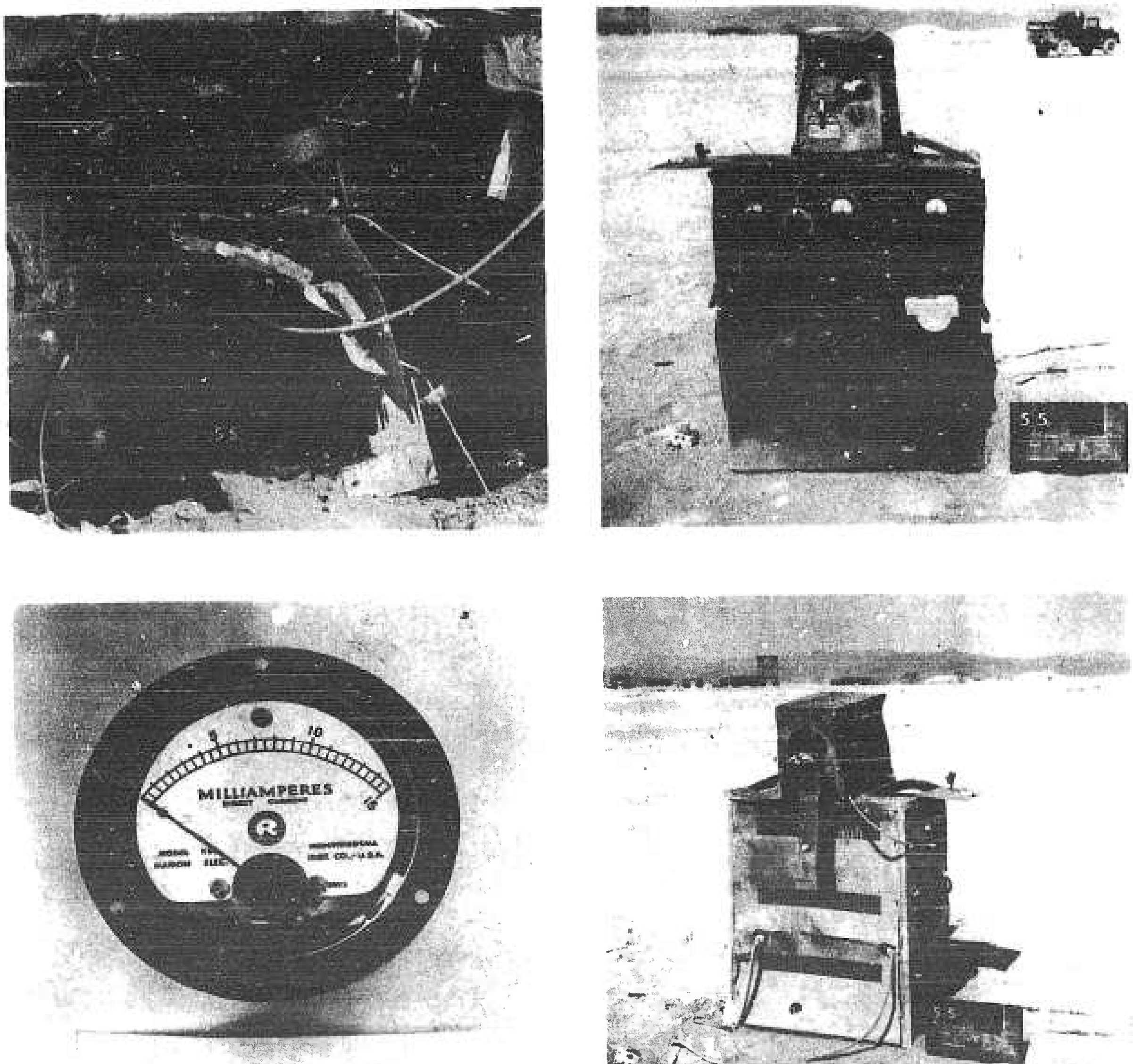


Fig. 3.113 Shot 9, Test Group 55, AN/GRC-26 Radio Set Details. (Top, Interior View before Blast, Bottom, Interior View after Blast.) Radio Receiver Taken out before Picture Taken. 1700 ft, 91 cal, 13.8 psi, 3600 r at Surface, 572 r in Shelter.



Ruggedized Meter in AN/GRC-26 Transmitter

Fig. 3.113A Shot 9, Test Group 55, AN/GRC-26 Radio Set Detail Photos - All Photos after Shot. Top left, interior of S-56 Shelter; Bottom left, ruggedized Milliammeter in BC-610 Transmitter; Top right, BC-610 Transmitter after Removal from S-56 Shelter, Front View. 1700 ft, 91 cal, 13.8 psi.

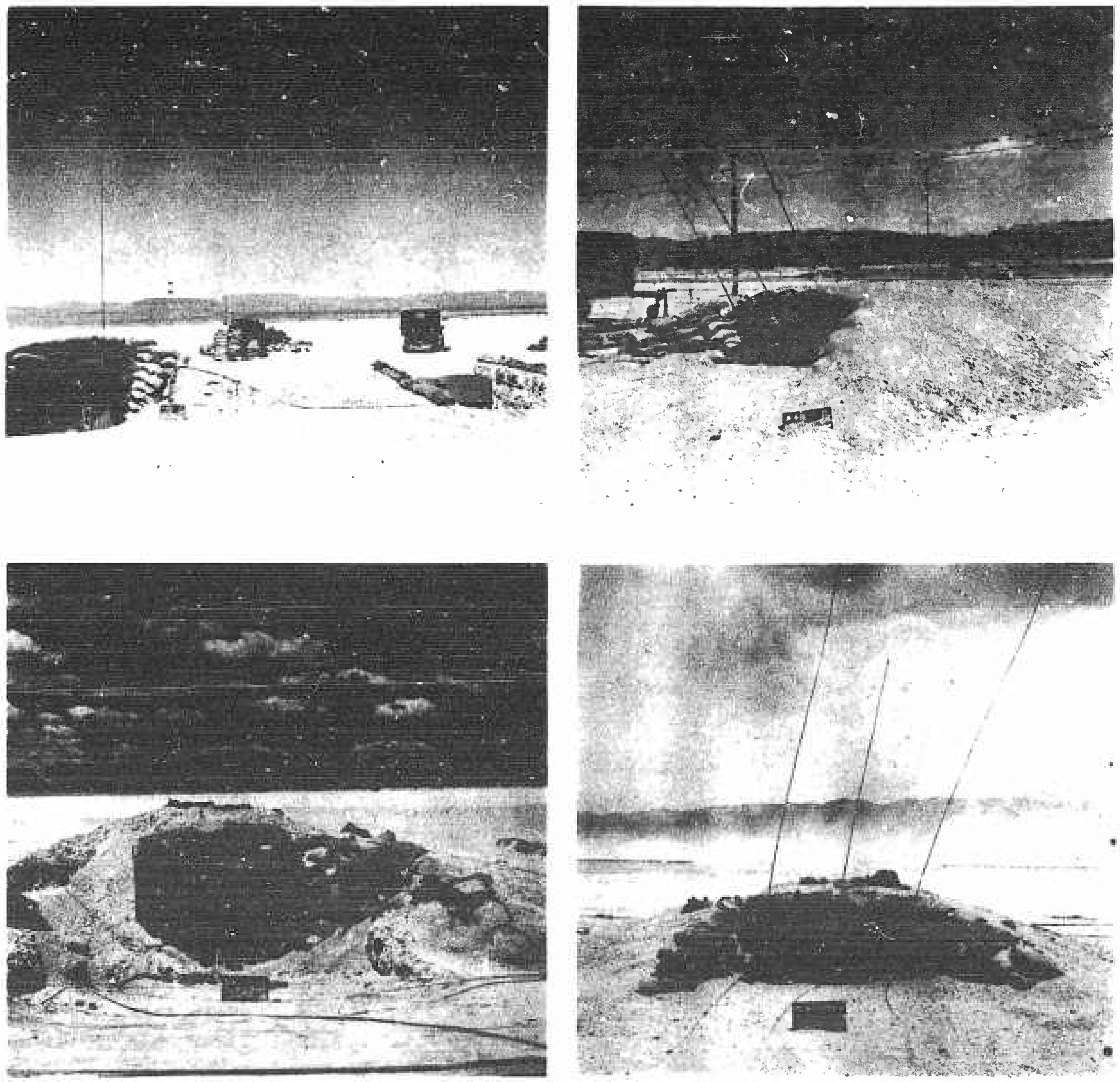


Fig. 3.114 Shot 9, Test Group 56, AN/GRC-26 Radio Set (Revetted). (Top left-before, Bottom left-after, Top right, Rear View-before, Bottom right, Rear View-after.) 3500 ft, 49 cal, 9.4 psi, 840 r at Surface, 316-168 r in S-56 Shelter.

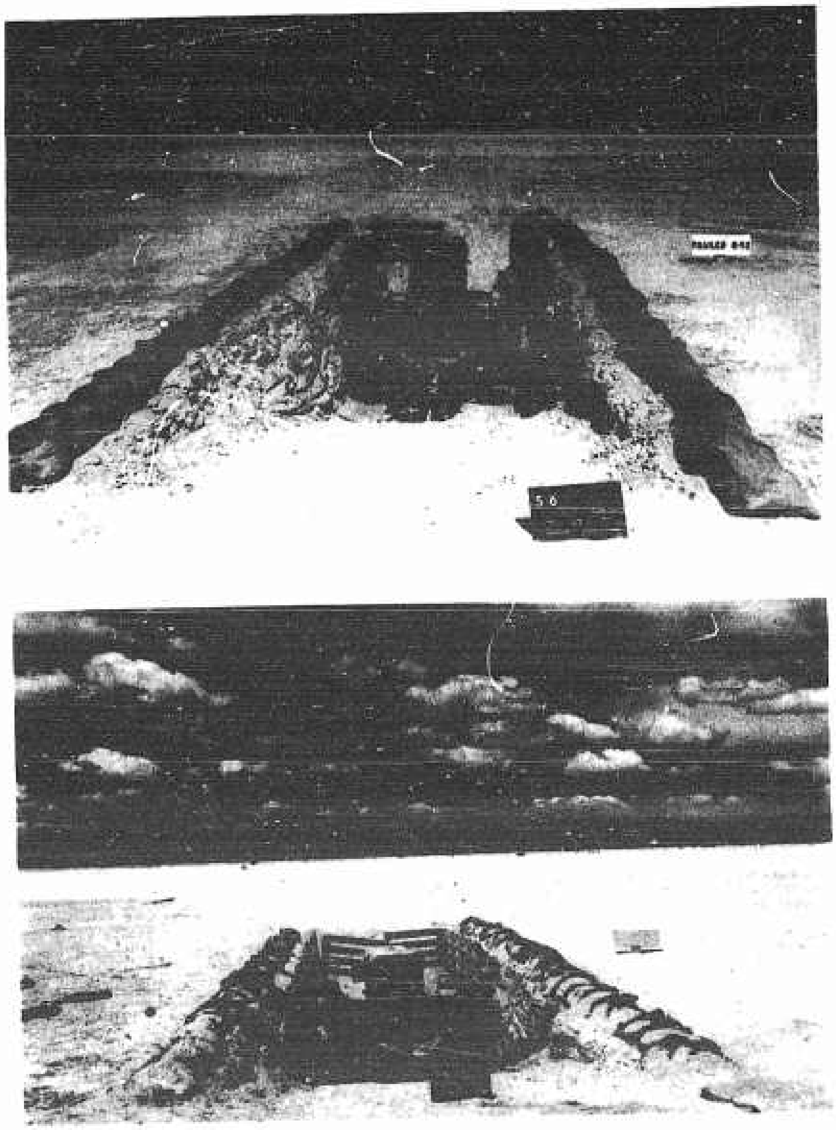


Fig. 3.115 Shot 9, Test Group 56, PE-95 Power Unit, Part of AN/GRC-26 Radio Set (In Open Ended Pit). (Top-before, Bottom-after) 3500 ft, 49 cal, 9.4 psi.

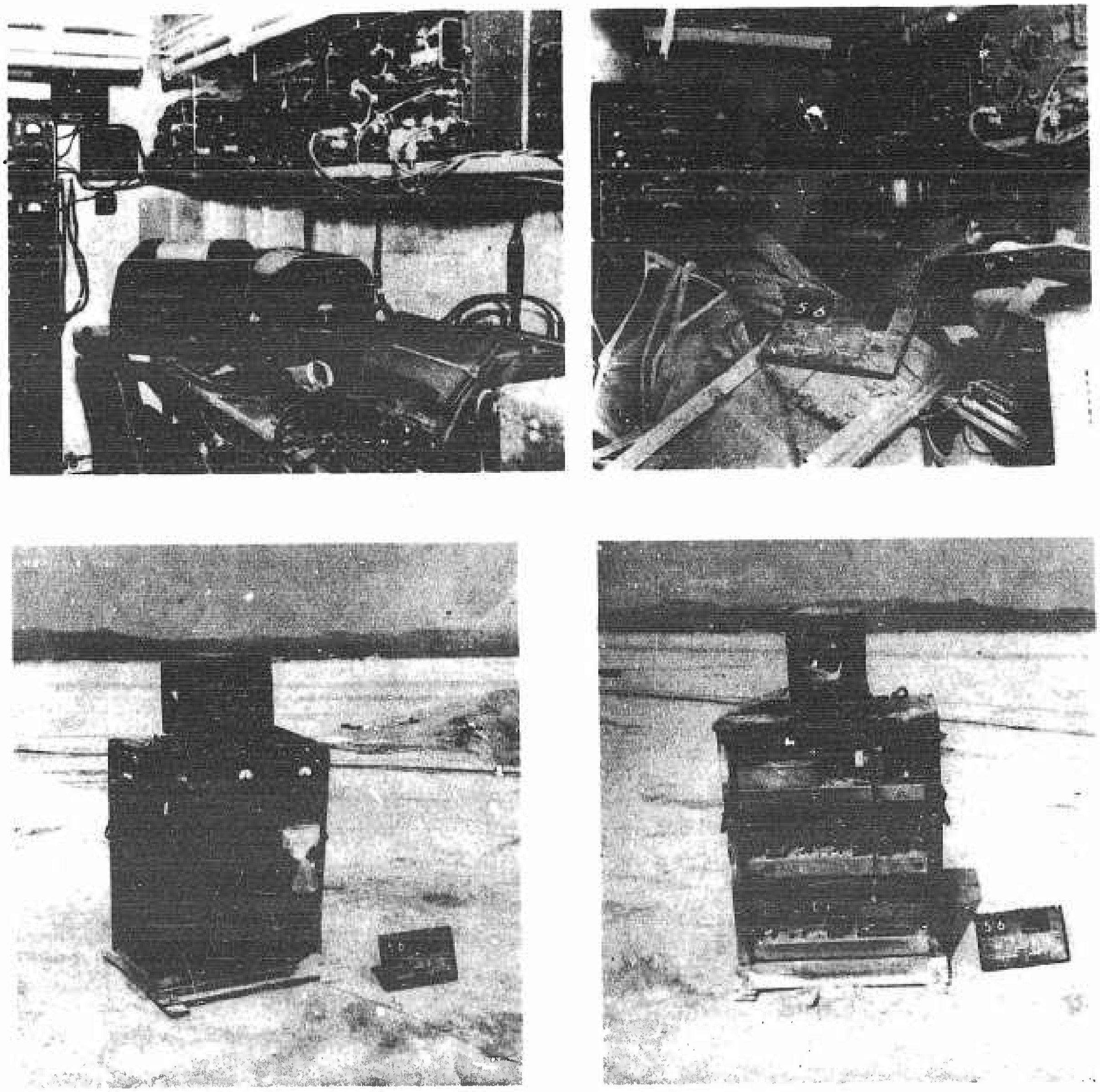


Fig. 3.116 Shot 9, Test Group 56, AN/GRC-26 Radio Set Detail Photos (After). Top left, interior of S-56 Shelter before blast; lower left, BC-610 Transmitter, front view; bottom right, BC-610 Transmitter, rear view, panel removed; top right, shelter interior after blast. 3500 ft, 49 cal, 9.4 psi, 840 r at surface, 316-168 r in shelter.

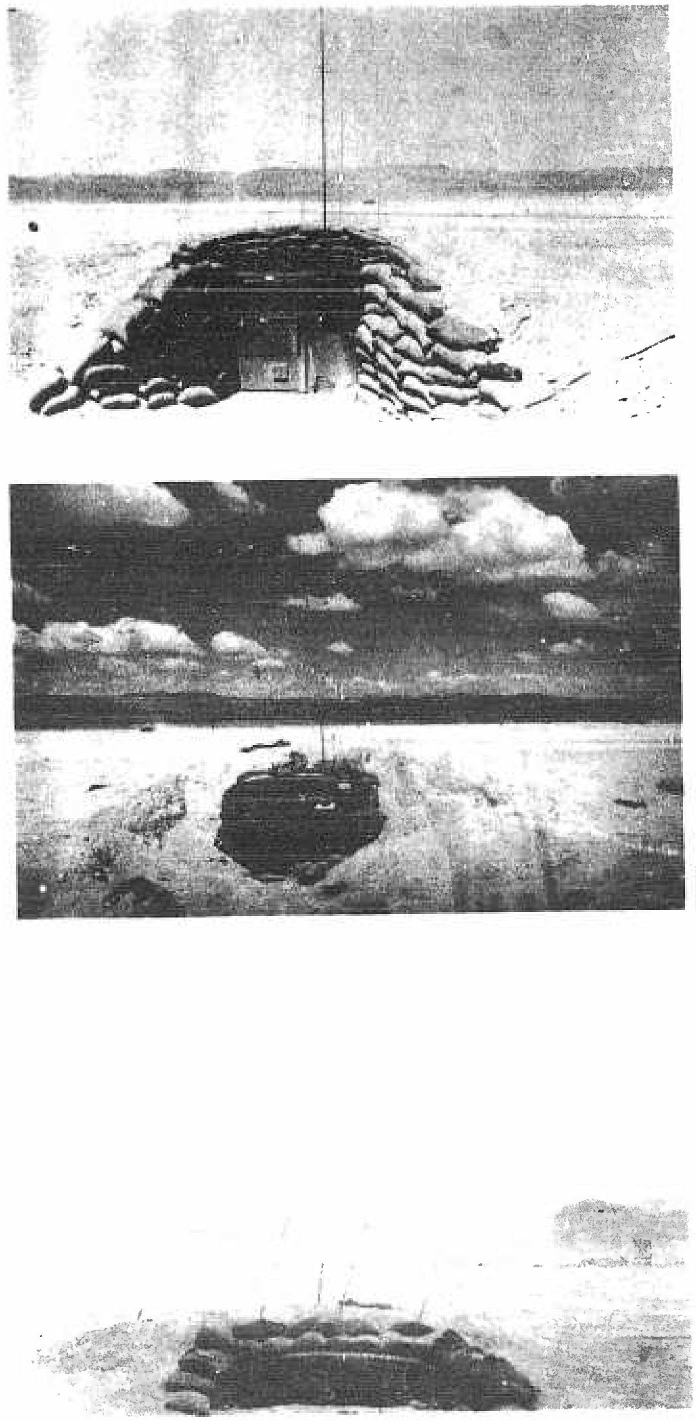


Fig. 3.117 Shot 9, Test Group 57, AN/GRC-26 Radio Set. (Top-before, Center-after, Bottom, Rear View-after) 4500 ft, 34 cal, 7 psi, 200 r at Surface, 96 r in S-56 Shelter.

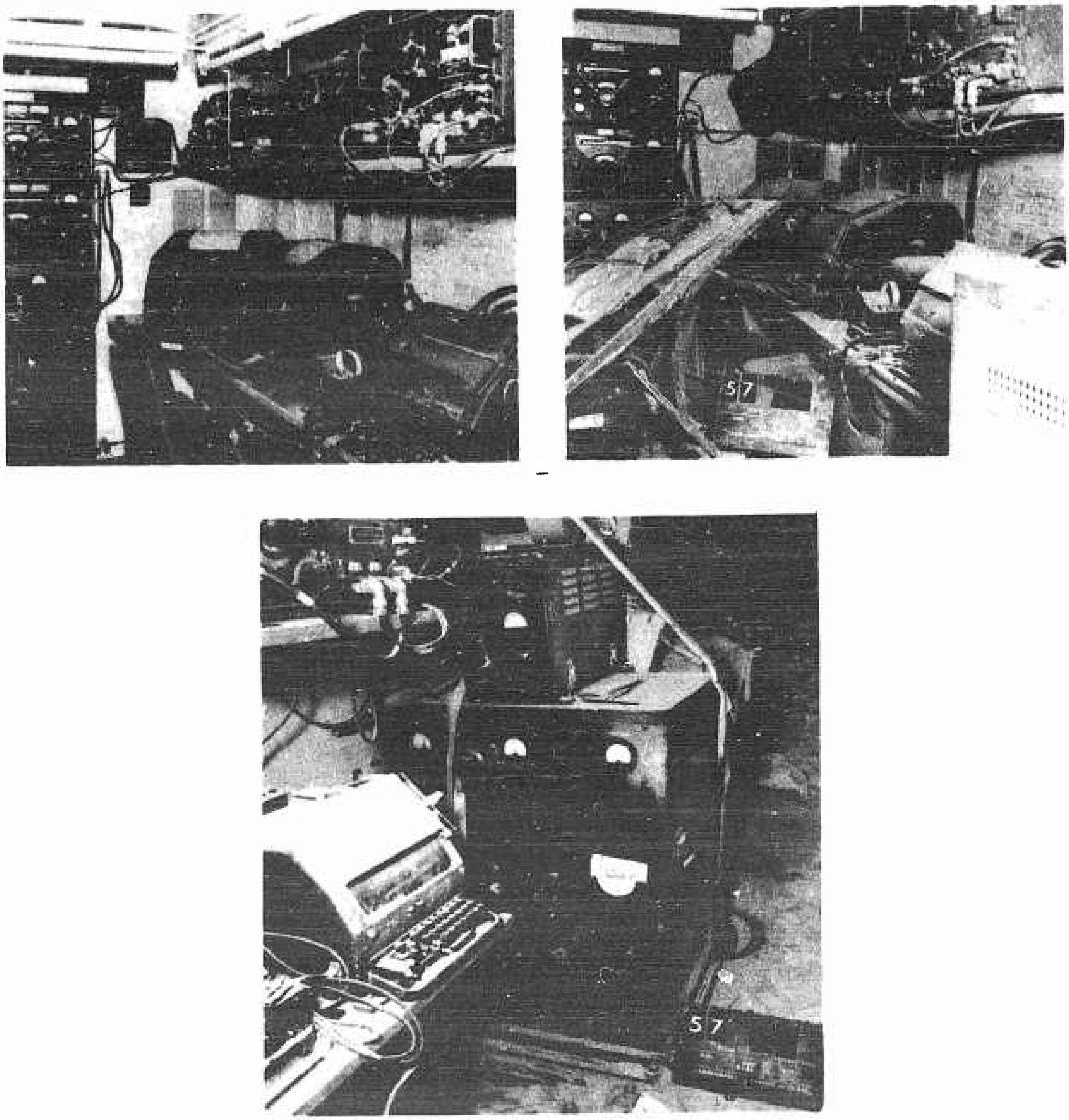


Fig. 3.117A Shot 9, Test Group 57, AN/GRC-26 Details. (Top left-interior View before Blast, Top right and Bottom, Interior View after Blast) 4500 ft, 34 cal, 7 psi, 200 r at Surface, 96 r in Shelter.

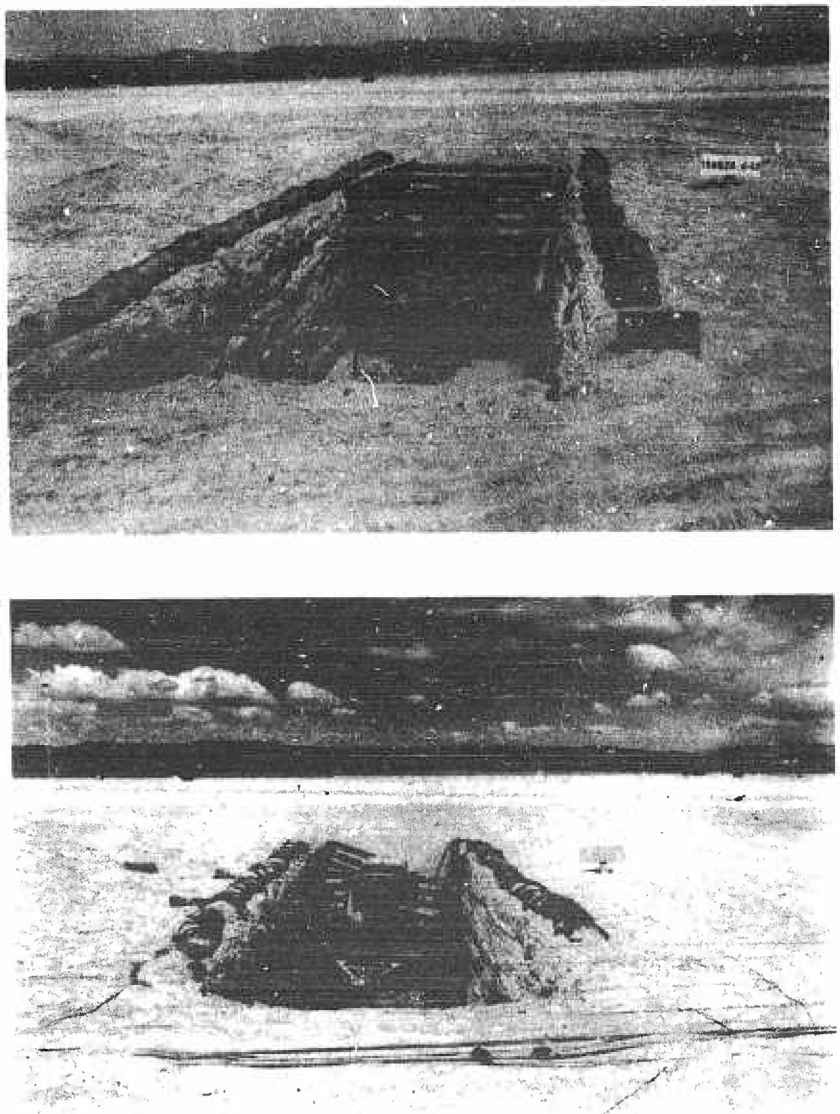


Fig. 3.118 Shot 9, Test Group 57, PE-95 Power Unit in S-56 Shelter. (Top-before, Bottom-after) 4500 ft, 34 cal, 7 psi, 200 r at Surface, 96 r in S-56 Shelter.

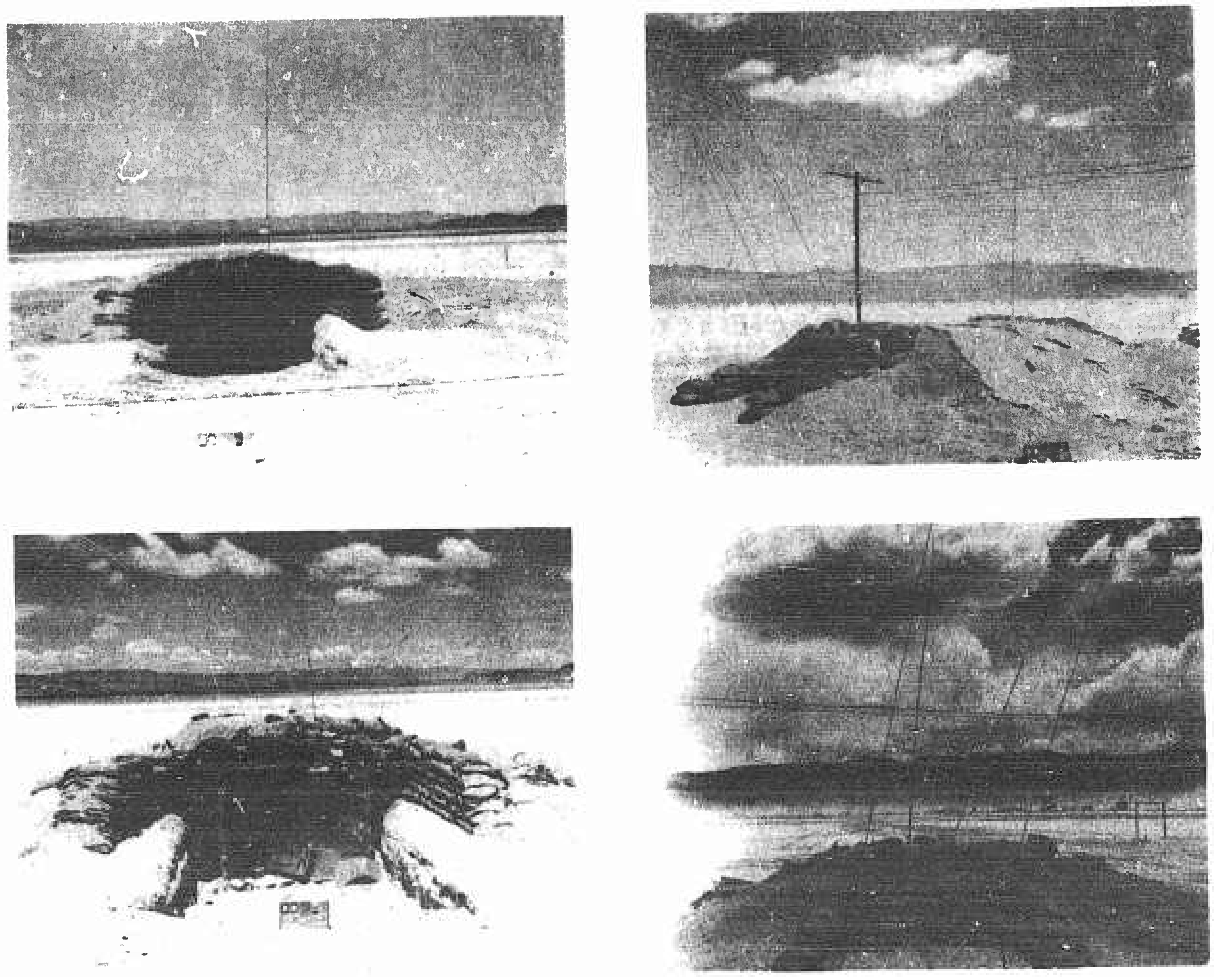


Fig. 3.119 Shot 9, Test Group 58, AN/GRC-26 Radio Set. (Top left-before, Bottom left-after; Top right, rear view-before, Bottom right, rear view-after) 5500 ft, 25 cal, 5.6 psi, 80 r at Surface, 44 r in S-56 Shelter.

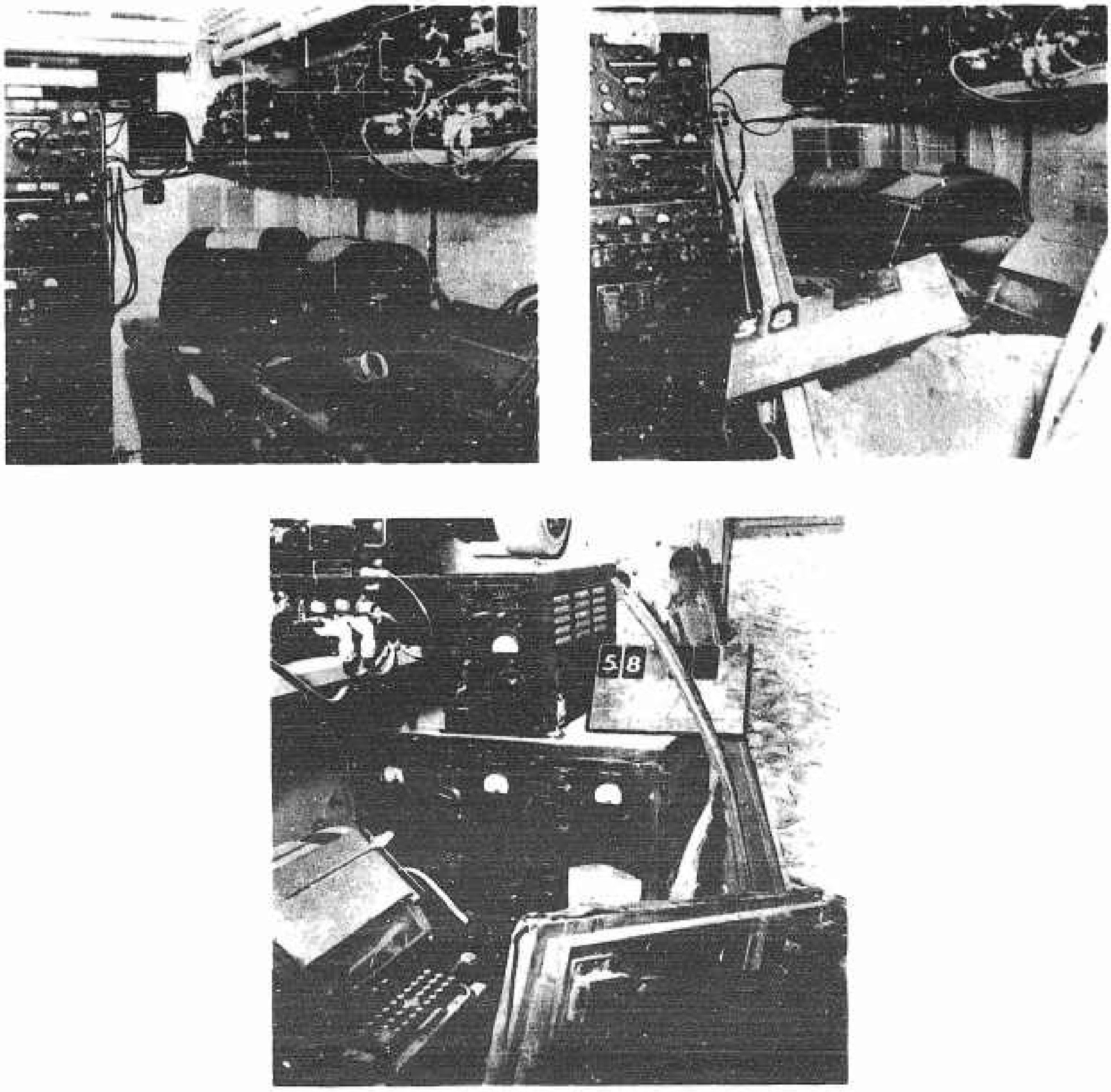


Fig. 3.120 Shot 9, Test Group 58, AN/GRC-26 Radio Set, Detail Photos. (Top left, Interior View before Blast; Top right and Bottom, Interior Views of S-56 Shelter after Blast.) 5000 ft, 25 cal, 5.6 psi, 80 r at Surface, 44 r in S-56 Shelter.

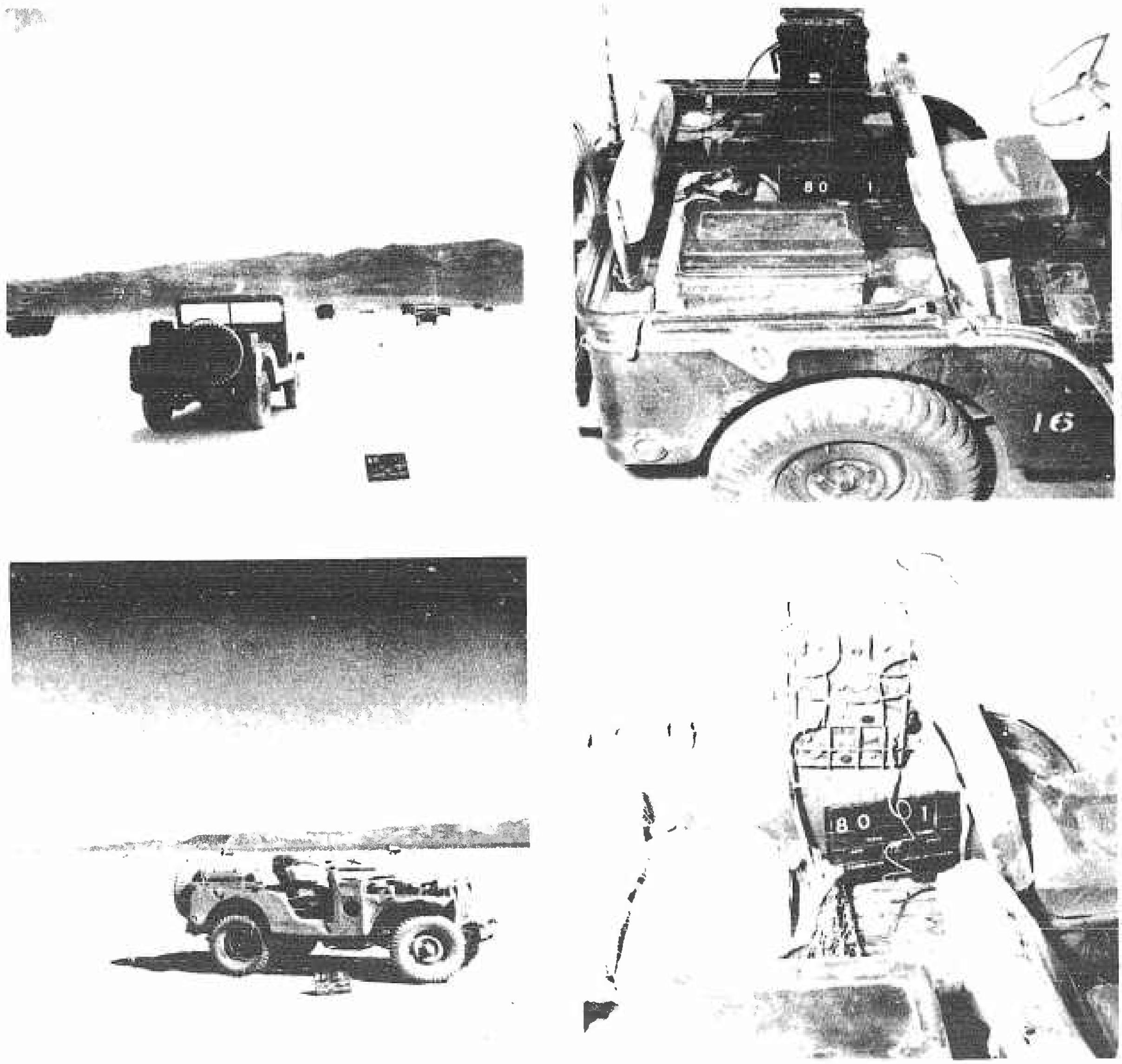


Fig. 3.121 Shot 9, Test Group 80, AN/GRC-9 Radio Set in Ordnance Corps Jeep. (Top left-before, Bottom left-after; Top right-before, Bottom right-after) 1650 ft, 94.5 cal, 14 psi, 368 r at Surface.

Fig. 3.122 Shot 9, Test Group 81, AN/GRC-26 in Ordnance Corps 2-1/2 Ton Truck. (Top-before, Center-after, Bottom, Interior of AN/GRC-26 Radio Set-after) 2425 ft, 58.5 cal, 10.6 psi, 2280 r at Surface, Interior Gamma Radiation not Known.

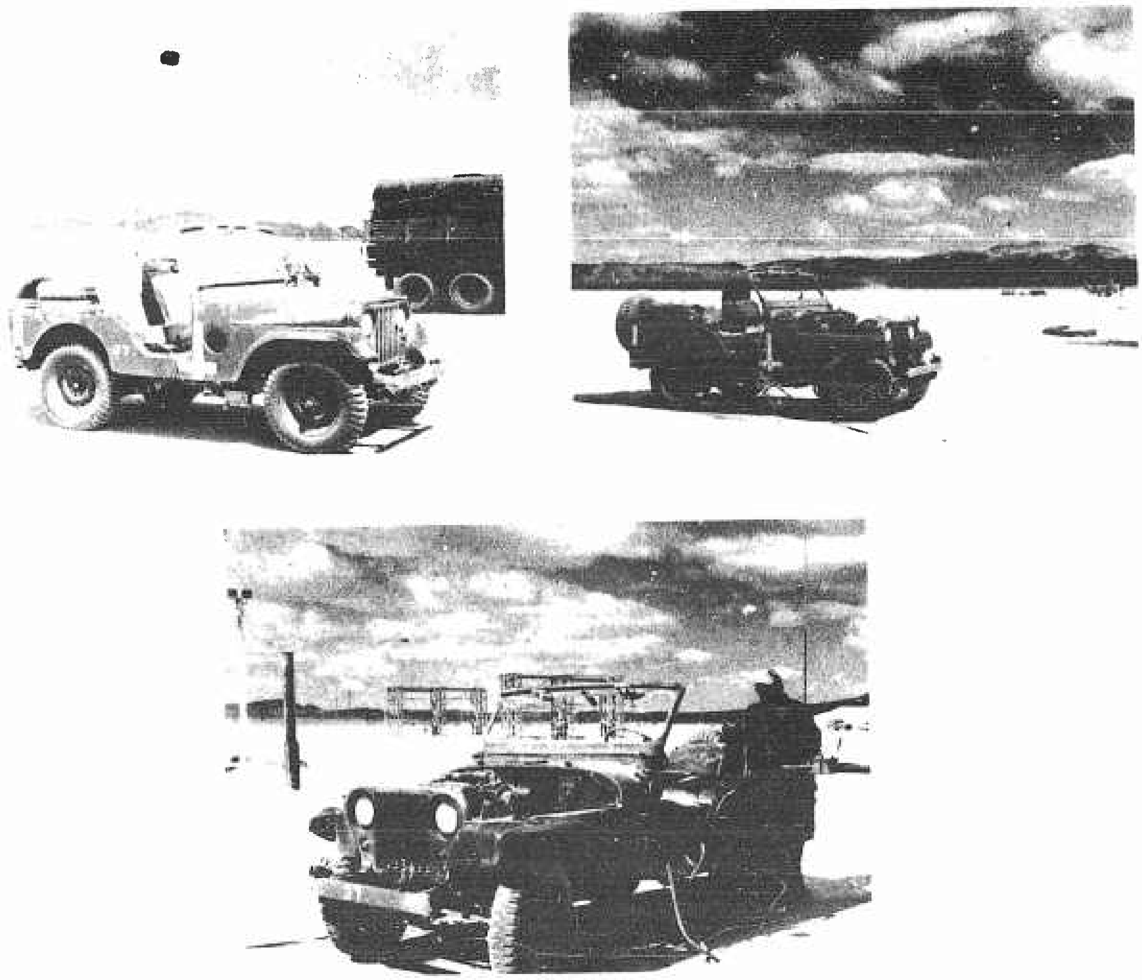


Fig. 3.123 Shot 9, Test Group 81, AN/GRC-9 on Ordnance Corps Jeep. (Top left-before, Top right-after, Bottom, Front View-after) 2425 ft, 58.5 cal, 10.6 psi, 2280 r at Surface.

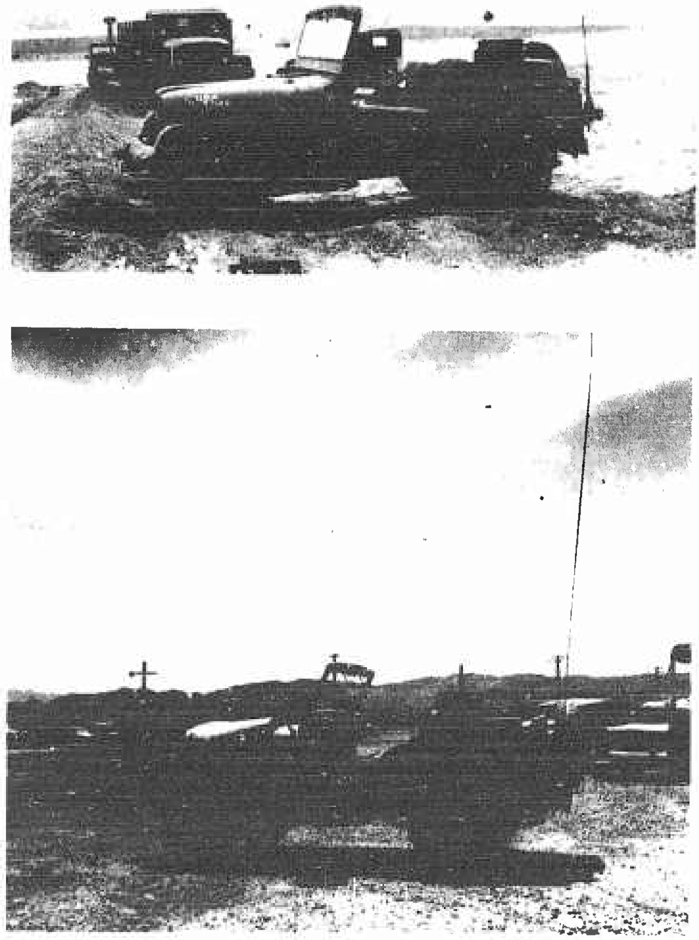


Fig. 3.124 Shot 9, Test Group 82, Radio Set AN/GRC-9 in Ordnance Jeep. (Top-before, Bottom-after. Bottom View Taken after Jeep had been Driven Under its Own Power from the Test Site.) 4550 ft, 33.5 cal, 6.9 psi.

TABLE 3.16 - Damage Summary of Antennas and Masts

Test Groups 39 - 54 and 100 - Shot 9

Test Group No.	Ft from GZ	Cal.	psi	Damage Thermal	Damage Blast	Remarks[1]
39 - AB-26/CR	4050	40.5	8	N	S	Collapsed
40 - AB-26/CR	4600	32.5	6.8	N	S	Collapsed
41 - AB-224/U	4625	32.5	6.8	N	S	Collapsed
42 - AS-19/TRC-1	4650	32.5	6.8	M	S	Collapsed
43 - AS-19/TRC-1	4900	29.5	6.2	M	S	Collapsed
44 - AB-155/U	4900	29.5	6.2	N	S	Collapsed
45 - Lt Wt Mag. 30 ft	4925	29.5	6.2	N	S	Collapsed
46 - Lt Wt Fiber-glass 30 ft	4950	29.5	6.2	N	S	Collapsed
47 - AN/GRA-4	5000	28.5	6.0	N	S	Collapsed
48 - AN/GRA-4	5000	28.5	6.0	N	S	Collapsed
49 - AB-26/CR	5550	25	5.4	N	S	Collapsed
50 - AB-224/U	5575	25	5.4	N	S	Negligible
51 - Lt Wt Mag.	5550	25	5.4	N	M	Antenna distorted and bent
52 - AB-155/U	5625	24.5	5.4	N	S	Collapsed
53 - Lt Wt Fiber-glass	5575	24.5	5.4	N	S	Collapsed
54 - AB-155/U	5675	24	5.3	N	S	Collapsed
100 - AS-19/TRC-1	6350	19.5	4.6	N	S	Collapsed

Note 1: In all instances antenna hardware, guys and some antenna mast sections are salvageable for reuse.

an S-56 Shelter mounted on an Ordnance Corps 2-1/2 ton truck). This shelter was sandbagged to the equipment weight of an AN/GRC-26 equipment. This test group was located 4550 ft from GZ.

b. RESULTS: Thise test groups received varying degrees of damage. A damage summary is shown in Table 3.17.

c. PHOTOGRAPHS: Pre- and post-Shot 9 photographs of Test Groups 55 - 58, 80 - 82 are shown in Figs. 3.111 - 3.124.

3.11 SHELTERS - TEST GROUPS 59 - 64, 80 - 82, SHOT 9 (FIGS. 3.125 - 3.133)

a. DESIGN: The S-56 shelters contained no equipment and were located with sandbags to the approximate weight of the AN/GRC-26 equipment. Film badges were placed in each shelter. Test Group 59 was placed 2325 ft from GZ. It was reveted and sandbagged in the same manner as Test Groups 55 through 58. The open end was faced away from GZ. The top was protected by 24 in. of earth cover. Test Groups 60 through 64 were placed on the surface at distances of 3050, 3100, 3650, 4650, and 5625 ft from GZ. The S-56 shelter (Test Group 60) at 3050 ft

TABLE 3.17 - Damage Summary

Radio Sets - Test Groups 55 Through 58, 80 Through 82 - Shot 9

Test Group No.	Ft from GZ	cal	psi	Surface Gamma	Interior Gamma	DAMAGE Thermal	DAMAGE Blast	DAMAGE Gamma	Remarks
AN/GRC-26 Radio Sets									
55	1700	91	13.8	3600	572	L	S	S	Paint burned on exposed parts of S-56 shelter. Some sandbags burned spilling sand. Front of S-56 shelter blown in. Debris and blast caused severe to no damage to equipment. Set not operative without major repairs. Whip antennas bent. PE-95 power unit received light damage and was operative after light repairs made. Gamma alone could cause 100% deaths to operating personnel.
81	2425	58.5	10.6	2280	Film Badges Burned	S	S	S	This radio set completely gutted by fire, whip antennas bent and blown off. Gamma alone could cause 100% deaths to operating personnel.
56	3500	49	9.4	840	316-168	L	S	S	Paint scorched on exposed parts of Shelter. Some sandbags burned, spilling sand. Front of S-56 shelter blown in. Debris and blast caused severe to no damage to equipment. Set not operating without major repairs. Whip antennas bent and one broken off at top.

TABLE 3.17 - Damage Summary (Continued)

Radio Sets - Test Groups 55 Through 58, 80 Through 82, Shot 9

Test Group No.	Ft from GZ	cal	psi	Surface Gamma	Interior Gamma	DAMAGE Thermal	Blast	Gamma	Remarks
									PE-95 power unit received light blast damage and was operative after minor repairs made. Gamma alone could cause over 20% deaths and incapacitate all for over three months.
57	4500	34	7	200	96	L	S	L	Paint scorched on exposed parts of S-56 shelter. Some sandbags burned, spilling sand. Front of S-56 shelter blown in. Debris and blast caused severe to no damage to equipment. Set not operative without major repairs. PE-95 Power Unit received light blast damage and was operative after minor repairs made. Gamma alone would not cause deaths or incapacitate operating personnel.
58	5550	25	5.6	80	44	N	S	L	Light scorching of paint. Some sandbags burned, spilling sand. Front of S-56 shelter blown in. Debris and blast caused moderate to no damage to equipment. Set not operative without major repairs. (This set had no PE-95 Power Unit in the test.) Gamma alone would not cause deaths or incapacitate operating personnel.

TABLE 3.17 - Damage Summary (Continued)

Radio Sets - Test Groups 55 Through 58, 80 Through 82, Shot 9

Test Group No.	Ft from GZ	cal	psi	Surface Gamma	Interior Gamma	DAMAGE Thermal	DAMAGE Blast	DAMAGE Gamma	Remarks
AN/GRC-9 Radio Sets									
80*	1650	94.5	14	3680	Not applicable	L	L	S	Chassis scorched, calibration charts burned. Antenna bent, some external connections broken. Case of PE-237 power pack dented and top loose. Set operative after minor repairs made. Gamma alone would cause 100% deaths to operating personnel.
81*	2425	58.5	10.6	2280	Not applicable	N	L	S	No thermal damage. Antenna bent and some external connections broken. Set operative after minor repairs. Gamma radiation alone would have caused 100% deaths to operating personnel.
82*	4550	33.5	6.9	200	Not applicable	N	L	M	No thermal damage. Antenna bent and some external connections broken. Set operative after minor repairs. Gamma alone not expected to cause any deaths. No immediate evacuation.

NOTE* Mounted in Ordnance Corps 1/4 ton Jeep.
Samples of damaged equipment returned to Coles Signal Laboratory where it has been analyzed in detail. The detailed analyses are on file at this Laboratory. The findings corroborate the damage criteria contained in this summary.

from GZ was modified by the addition of various types of insulating materials to the shelter walls. Heavy steel guys were used to tie down the shelters, since primary interest for these test groups was thermal effects (Test Groups 60 and 61). The other shelters were free to move.

(1) Test Group 80 consisted of an S-56 Shelter mounted on an Ordnance Corps 2-1/2 ton truck. (Test Group 80 also included an AN/GRC-9 radio set mounted in an Ordnance Corps 1/4 ton Jeep.) This test group was located 1650 ft from GZ.

(2) Test Group 82 consisted of an S-56 Shelter mounted on an Ordnance Corps 2-1/2 ton truck (Test Group 82 also included an AN/GRC-9 radio set mounted in an Ordnance Corps 1/4 ton Jeep). This test group was located 4550 ft from GZ.

b. RESULTS: The thermal damage to all shelters was light to none. All shelters received severe blast damage. Reference should also be made to Section 3.10 which contains a damage summary of the damage to AN/GRC-26 radio sets housed in S-56 type shelters. A damage summary of these test groups is shown in Table 3.18.

c. PHOTOGRAPHS: Pre- and post-Shot 9 photographs of these test groups are shown in Figs. 3.125 through 3.133.

3.12 SIGNAL SUPPLY POINTS — TEST GROUPS 65 THROUGH 69, AND 102, SHOT 9 (FIGS. 3.134 THROUGH 3.139)

a. DESIGN: Prototype signal supply points were located on the surface at distances of 1900, 3150, 3700, 4675, 5625, and 3175 ft from GZ. The supply point (Test Group 102) at 3175 ft was placed in a 4 ft deep trench. All other supply points were on the surface without cover or protection. Included in the supply points were items such as field wire on drums and in dispensers, cable, power units, and components of radio sets.

b. RESULTS: A damage summary for these test groups is shown in Table 3.19.

c. PHOTOGRAPHS: Pre- and post-Shot 9 photographs of these test groups are shown in Figs. 3.134 through 3.139.

3.13 FOXHOLES — TEST GROUPS 70 THROUGH 76, AND 101, SHOT 9 (FIGS. 3.140 THROUGH 3.149)

a. DESIGN: Foxholes 2 ft x 6 ft x 4 ft were located at 1000 ft intervals along the West side of the radial pole line, at distances of 1775, 2800, 3800, 4800, 5800, 6800, and 7800 ft from GZ. Each foxhole contained a fabric dummy stuffed with straw with a field type radio AN/PRC-6 or AN/PRC-10 strapped to its back. Each foxhole also contained an EE-8 field telephone. Film badges were placed on each dummy and a film badge was also placed in each foxhole. Test Group 101 consisted of two fabric dummies filled with straw and placed facing each other in a 2 ft x 6 ft x 4 ft foxhole located 1725 ft from GZ. This foxhole and the two dummies were part of Program 9. By mutual agreement two radio sets were provided from Project 3.20. One Radio Set AN/PRC-6 was placed in the arms of one of the dummies and a Radio Set AN/PRC-10 was placed in the arms of the other dummy. High speed photography of this installation was secured during the shot. A damage summary of these test groups is shown in Table 3.20.

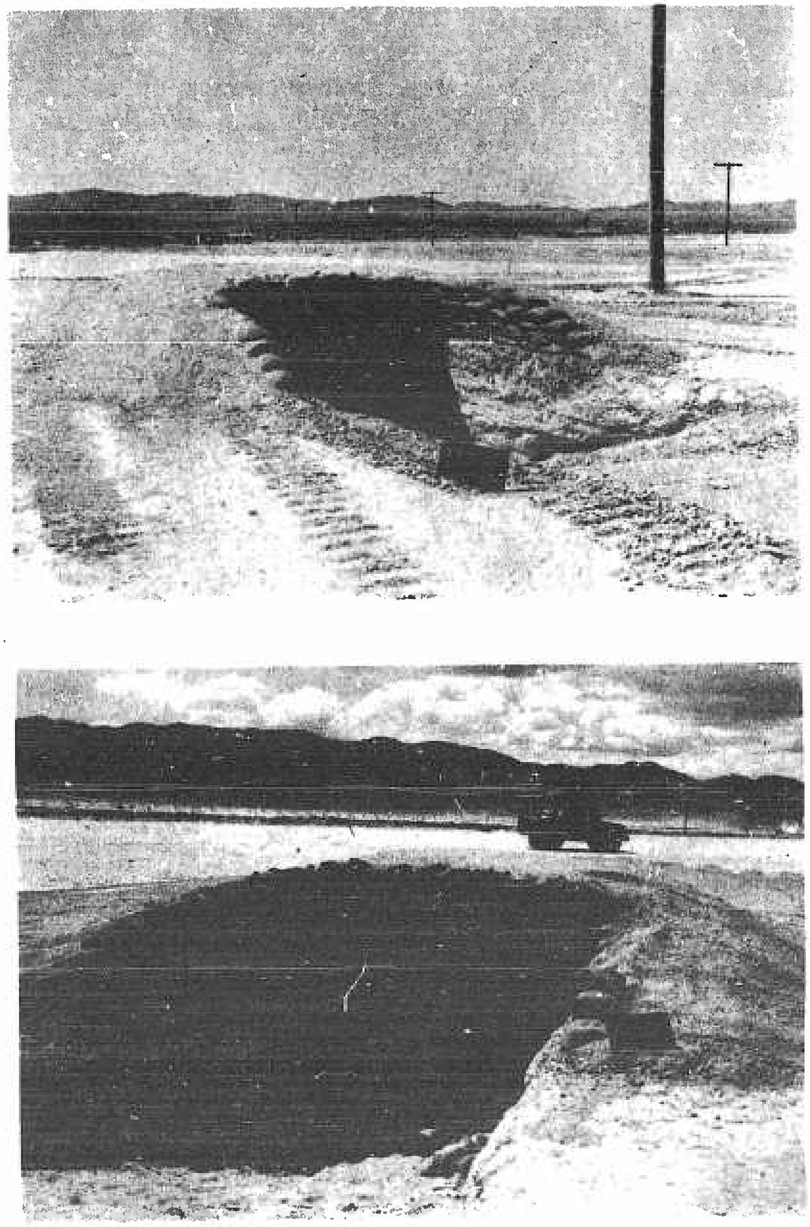


Fig. 3.125 Shot 9, Test Group 59, Shelter S-56 (Revetted) with Front Away from Ground Zero. (Top-before, Bottom-after) 2325 ft, 72 cal, 11.6 psi, 2440 r at Surface.

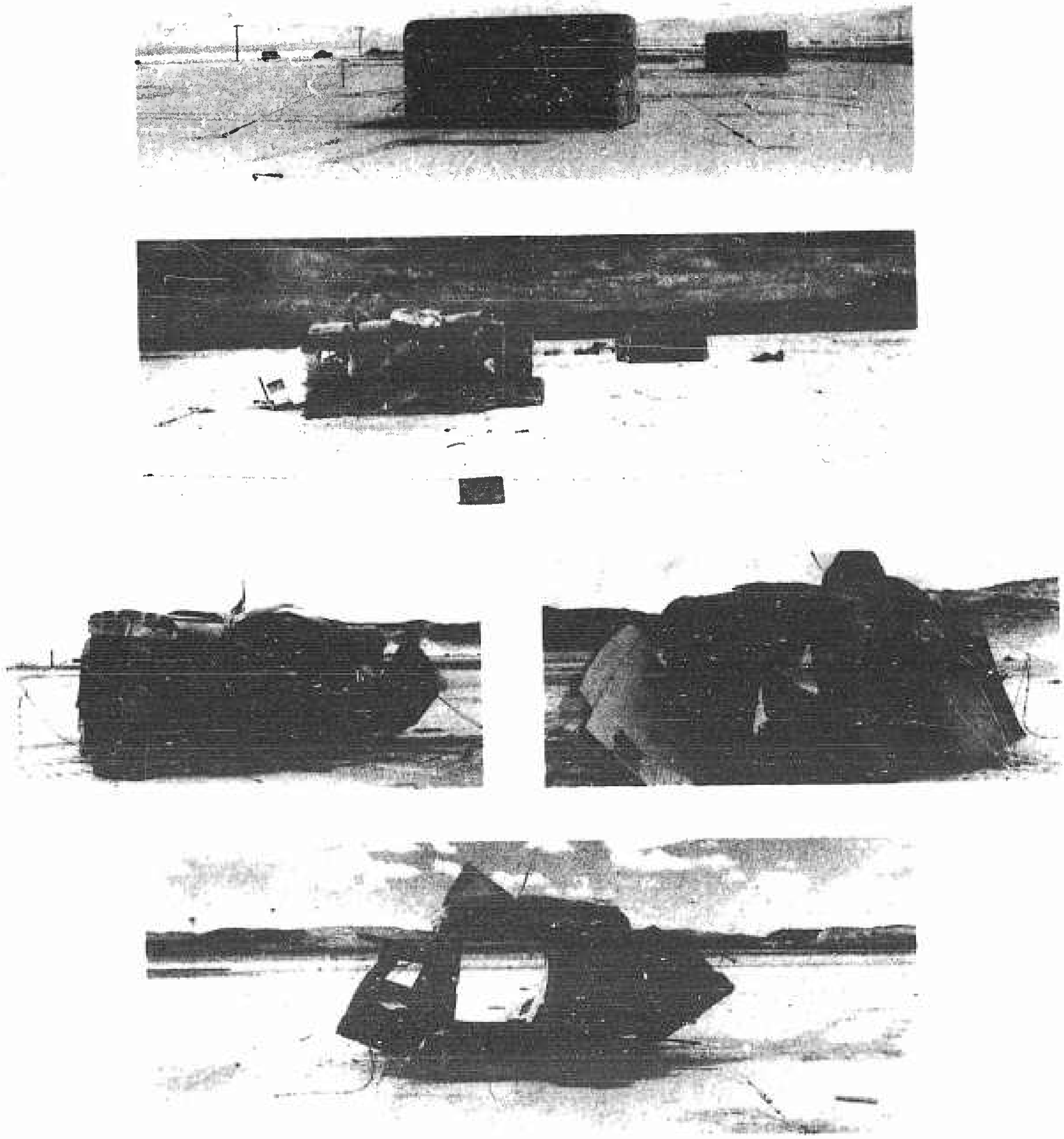


Fig. 3.126 Shot 9, Test Group 60, Shelter S-56 Modified. (Top-before, Second-after, Left, Side-after, Right, Rear-after, Bottom, Front-after) 3050 ft, 57.5 cal, 10.4 psi, 1480 r at Surface.

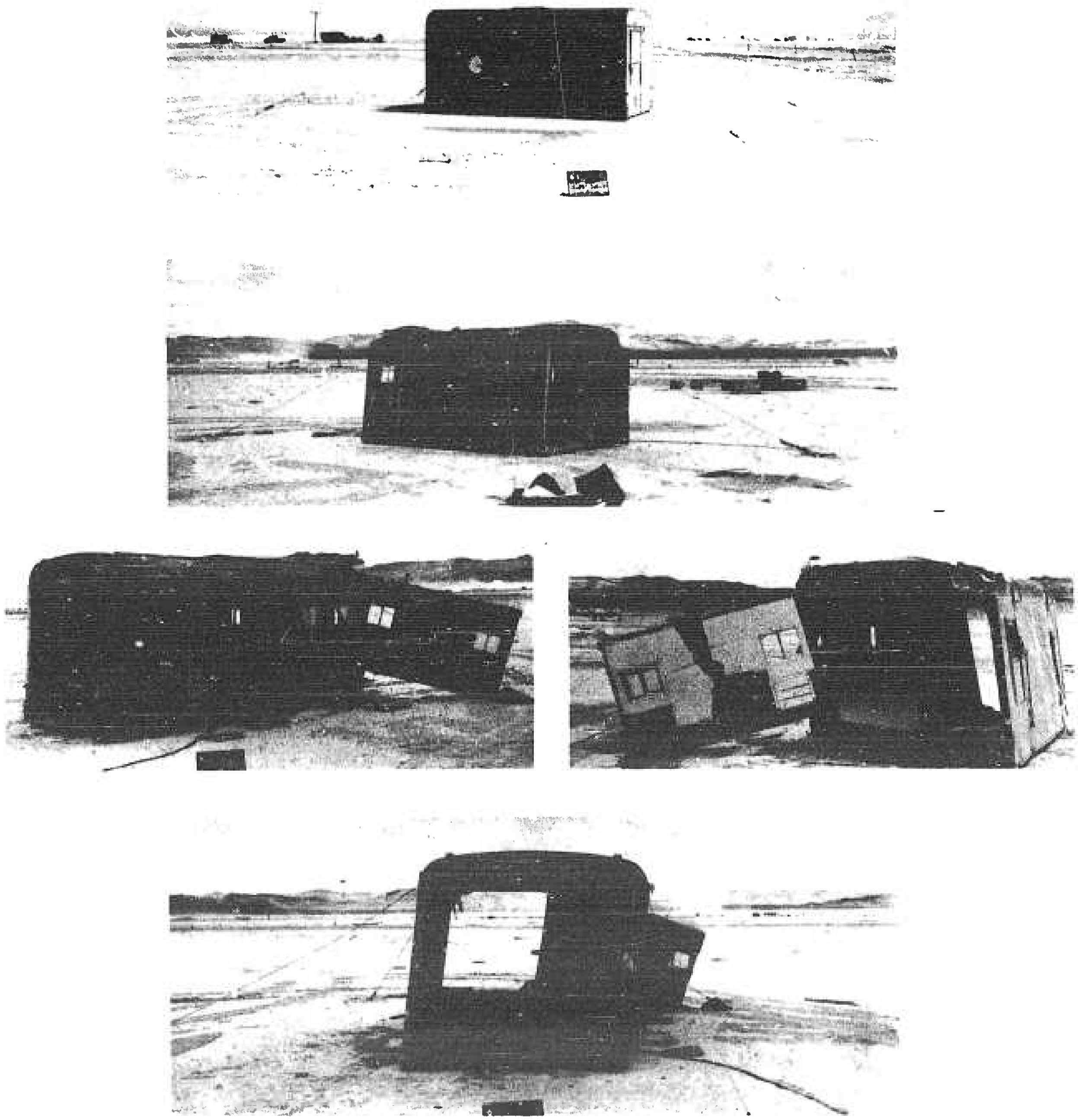


Fig. 3.127 Shot 9, Test Group 61, Shelter S-56 (Standard). (Top-before, Second-after, Left, Side-after, Right, Rear-after, Bottom, Front-after) 3100 ft, 56 cal, 10.4 psi, 1400 r at Surface.

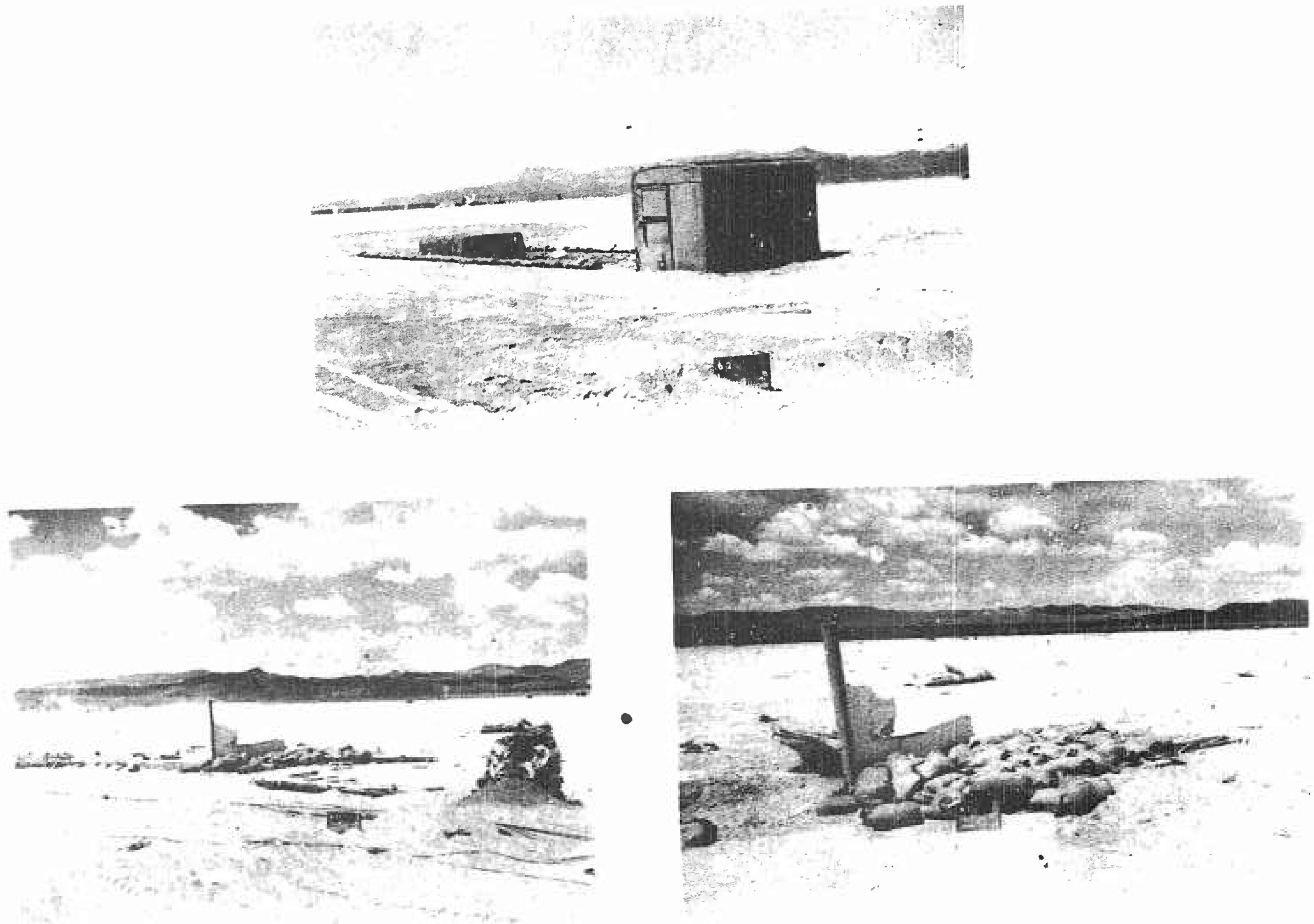


Fig. 3.128 Shot 9, Test Group 62, Shelter S-56.
(Top-before, Left-after, Right-after, Clos(-up)
3650 ft, 46 cal, 9.0 psi, 720 r at Surface.

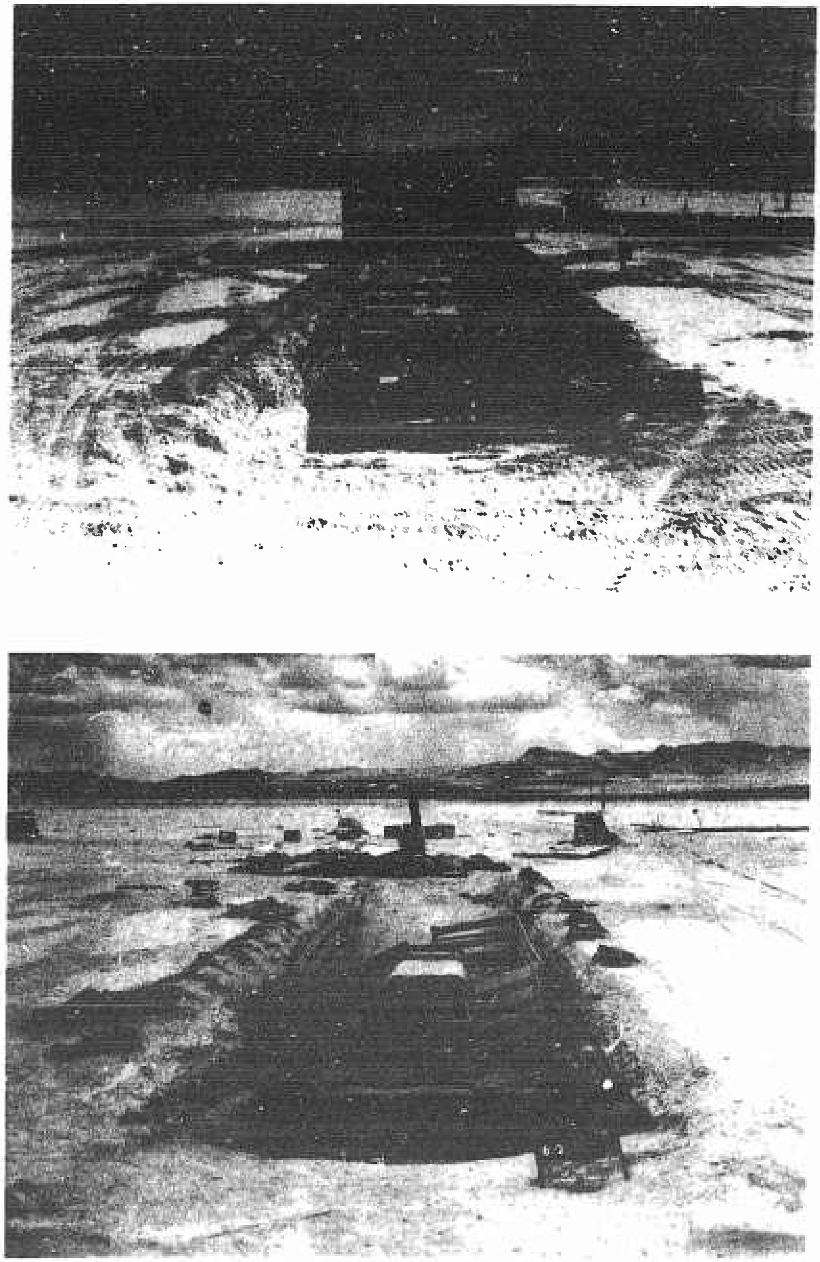


Fig. 3.129 Shot 9, Test Group 62, PE-95 Power Unit in K-52 Trailer in Open Pit Normal to Ground Zero. (Top-before, Bottom-after) 3650 ft, 46 cal, 9.0 psi.

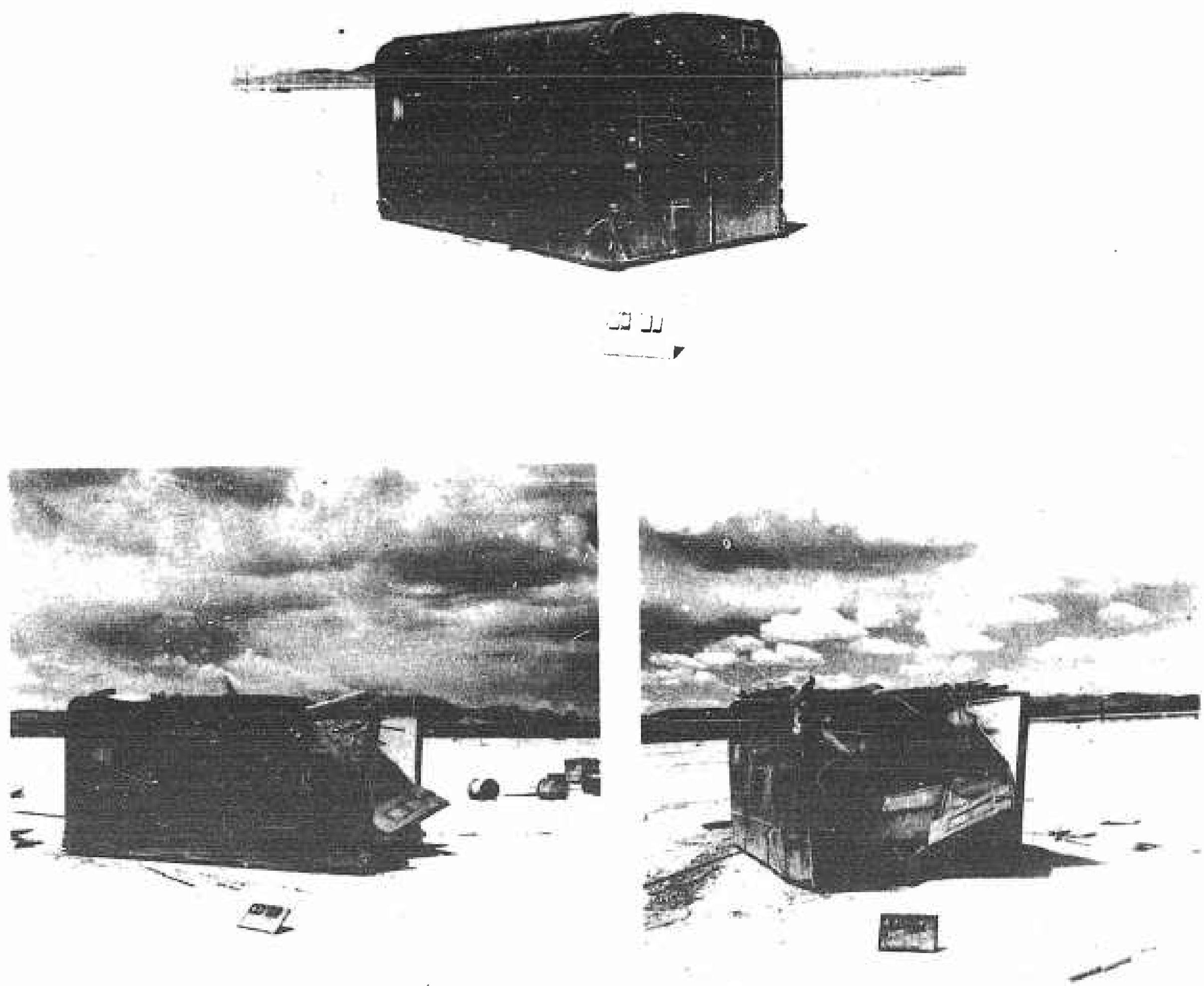


Fig. 3.130 Shot 9, Test Group 63, Shelter S-56. (Top-before, Bottom left-after, Side View, Bottom right-after, Front View) 4650 ft, 32.5 cal, 6.6 psi, 160 r at Surface.

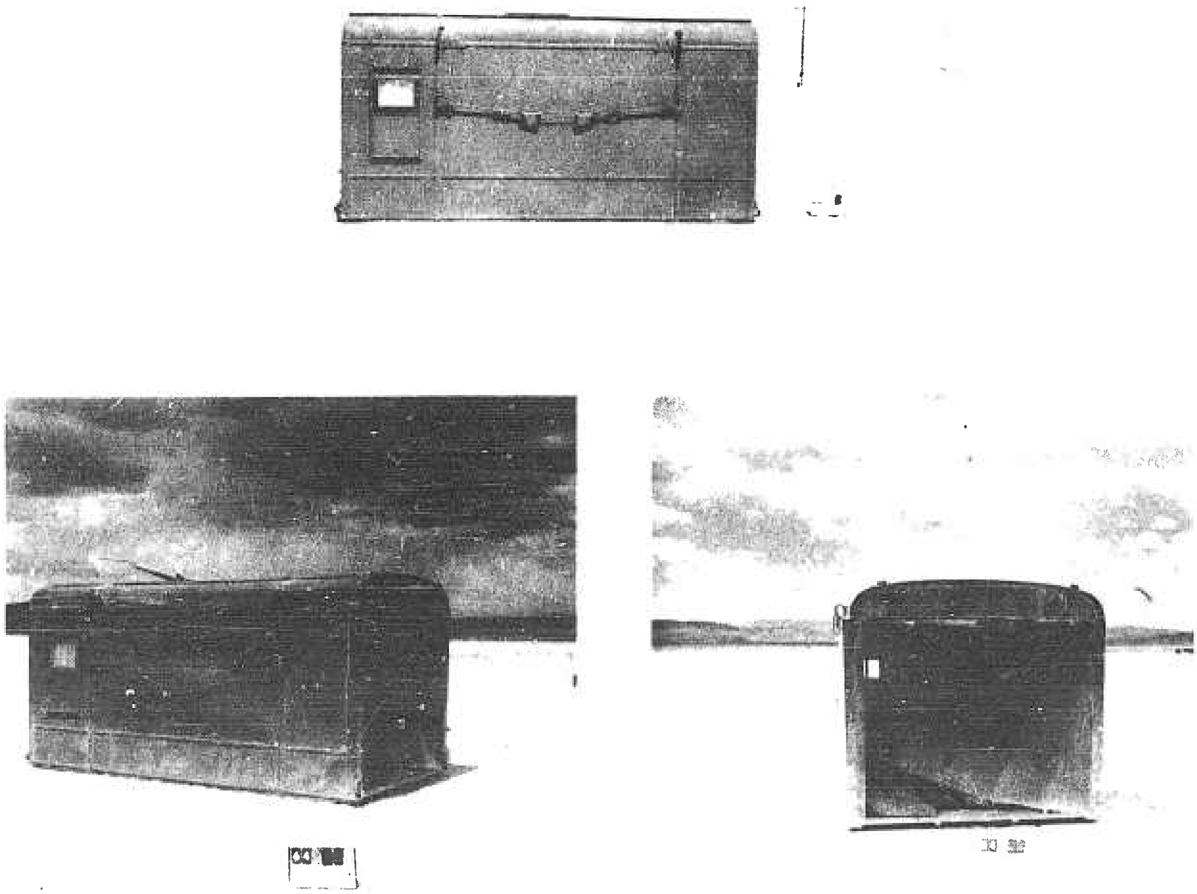


Fig. 3.131 Shot 9, Test Group 64, Shelter S-56. (Top-before, Bottom left-after, Side View, Bottom right-after, Front View) 5625 ft, 24 cal, 5.4 psi, 80 r at Surface.

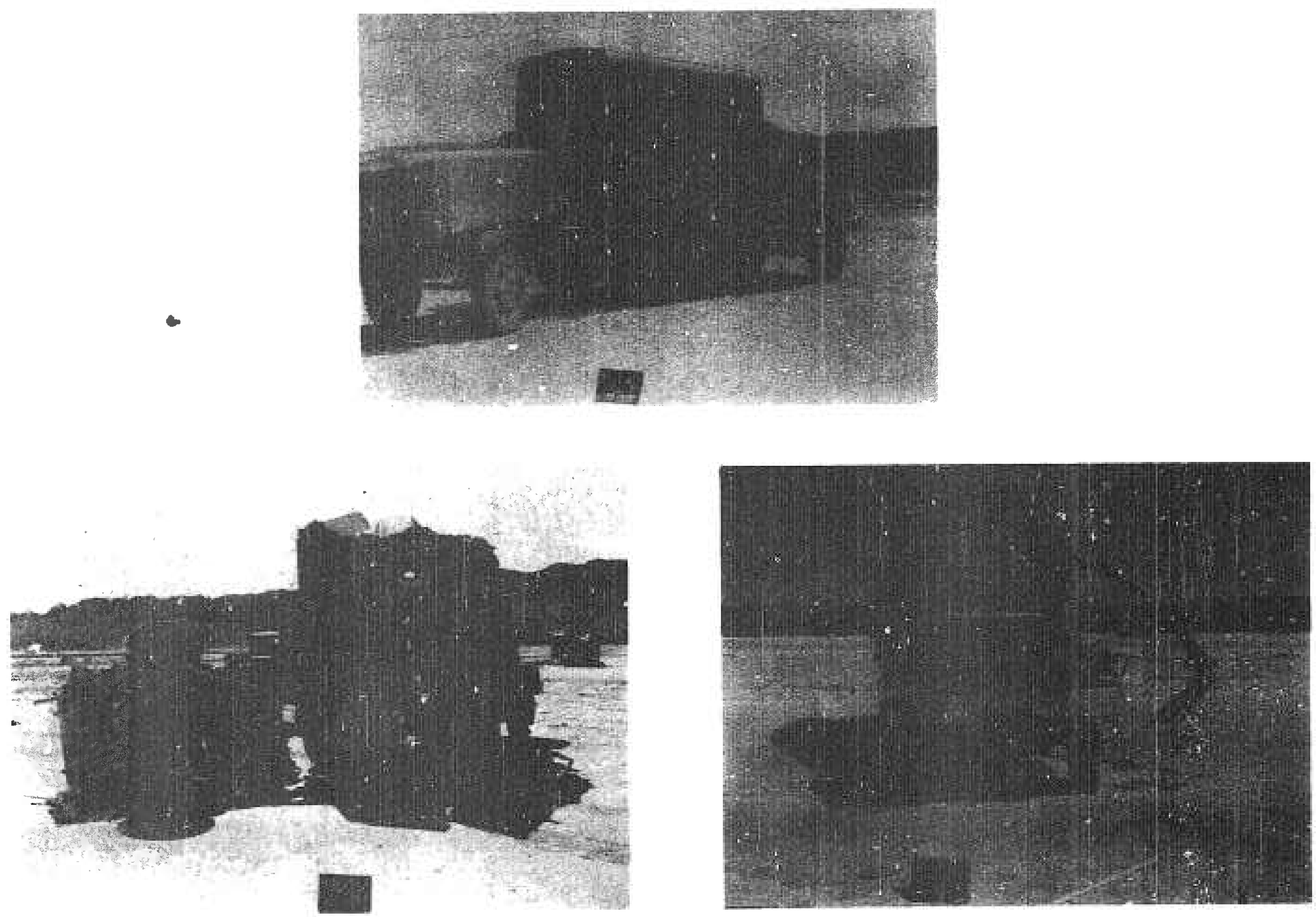


Fig. 3.132 Shot 9, Test Group 80, S-56 Shelter on Ordnance Corps 2-1/2 Ton Truck. (Top-before, Bottom left-after, Bottom right-after, Front View) 1650 ft, 94.5 cal, 14 psi, 3680 r at Surface.

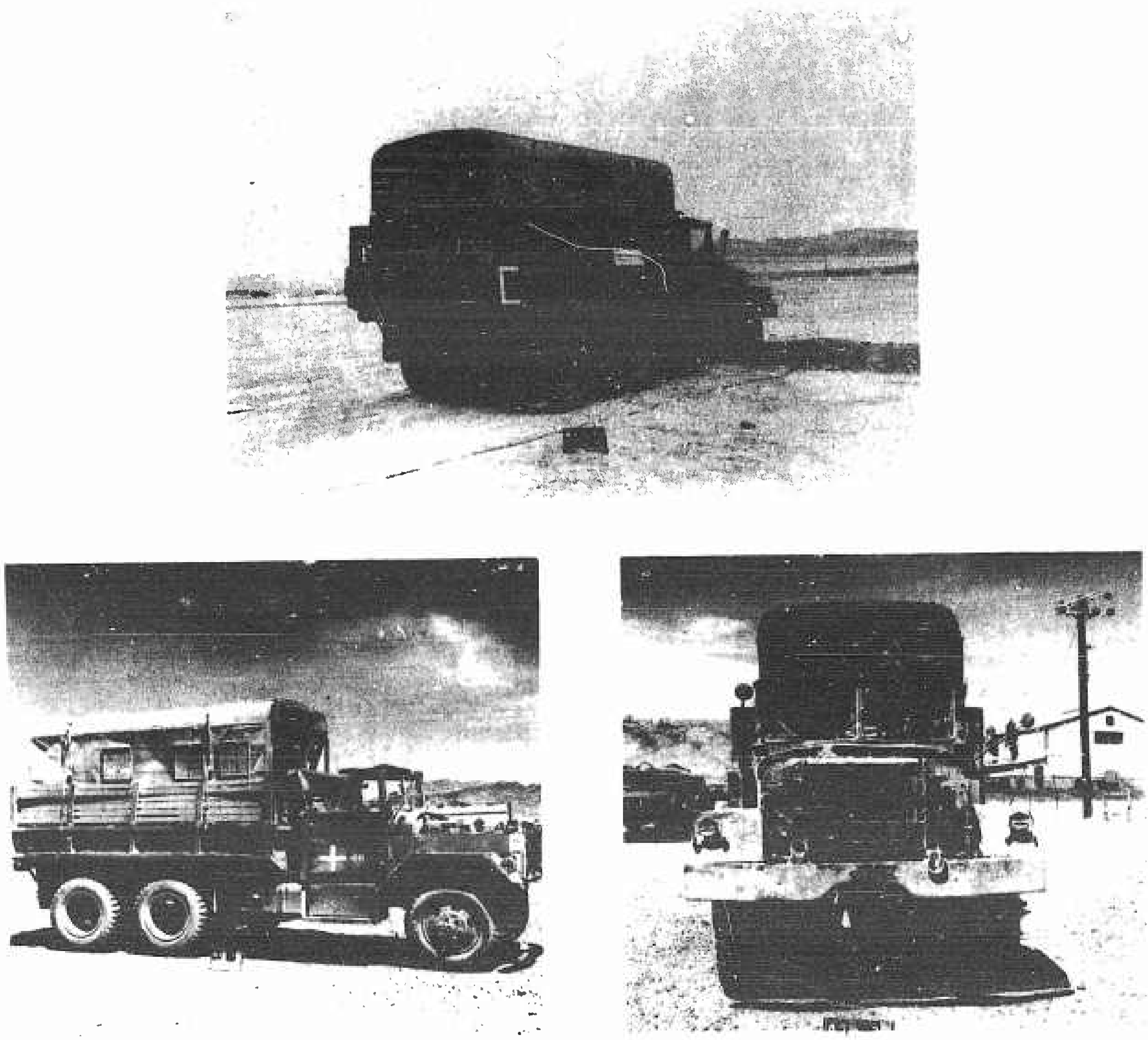


Fig. 3.133 Shot 9, Test Group 82, Shelter S-56 on Ordnance Corps 2-1/2 Ton Truck. (Top-before, Bottom left-after (Side View), Bottom right-after (Front View). Bottom Photos Taken Subsequent to Vehicle Being Moved under Its Own Power from the Test Site.) 4550 ft, 33.5 cal, 6.9 psi, 200 r at Surface.

Fig. 3.134 Shot 9, Test Group 65, Signal Supply Point.
(Top-before, Bottom-after)
1900 ft, 88.5 cal, 12.8 psi, 3160 r at Surface.

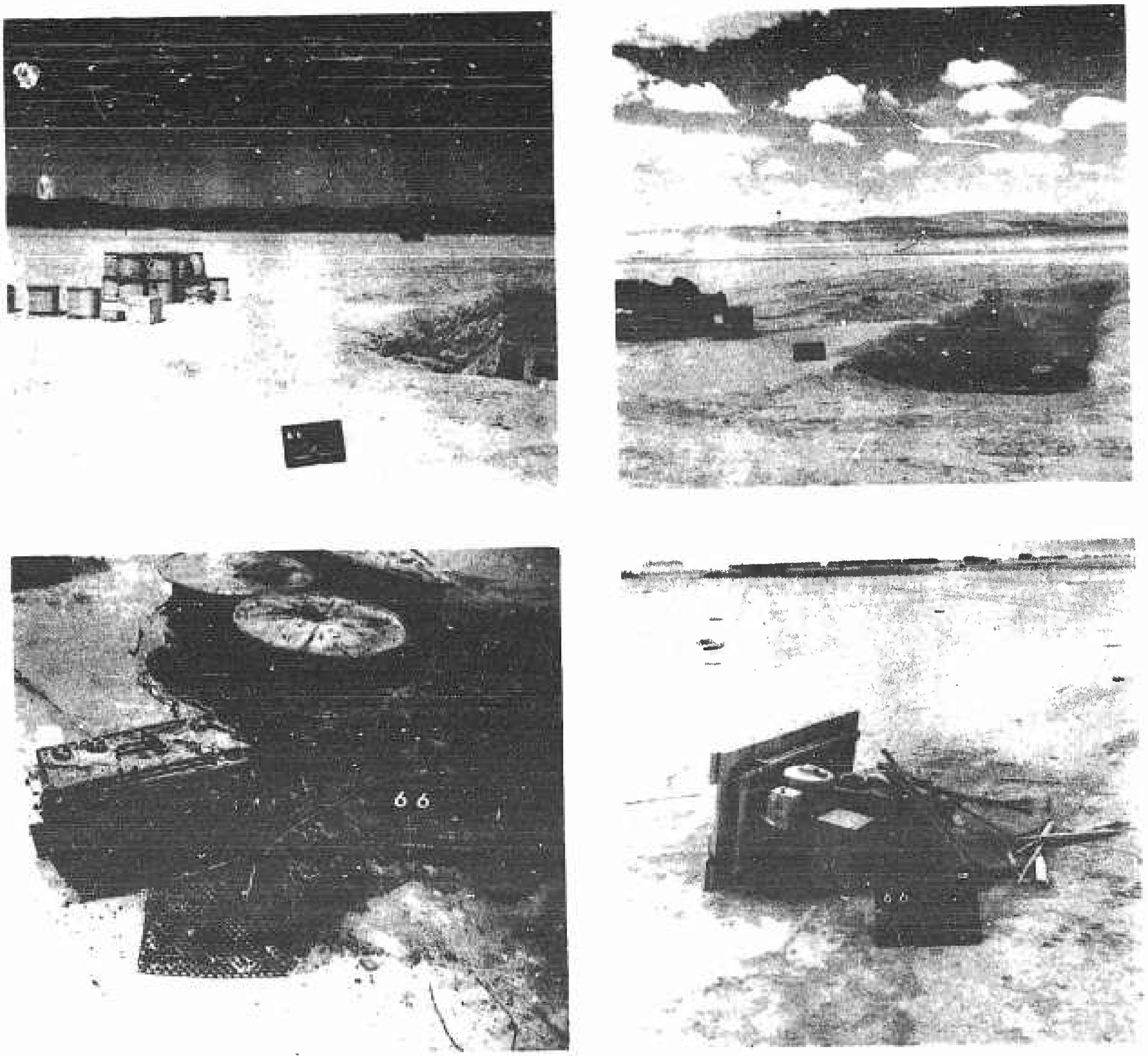


Fig. 3.135 Shot 9, Test Group 66, Signal Supply Point. (Top left-before, Top right-after, Bottom left-Close-up of AN/TRC-1 Transmitter-after, Bottom right-close-up of PE75 Power Unit-after) NOTE: Signal Supply Point in Open Pit in Top and Center of Photos. 3150 ft, 55 cal, 10.2 psi, 1160 r at Surface.

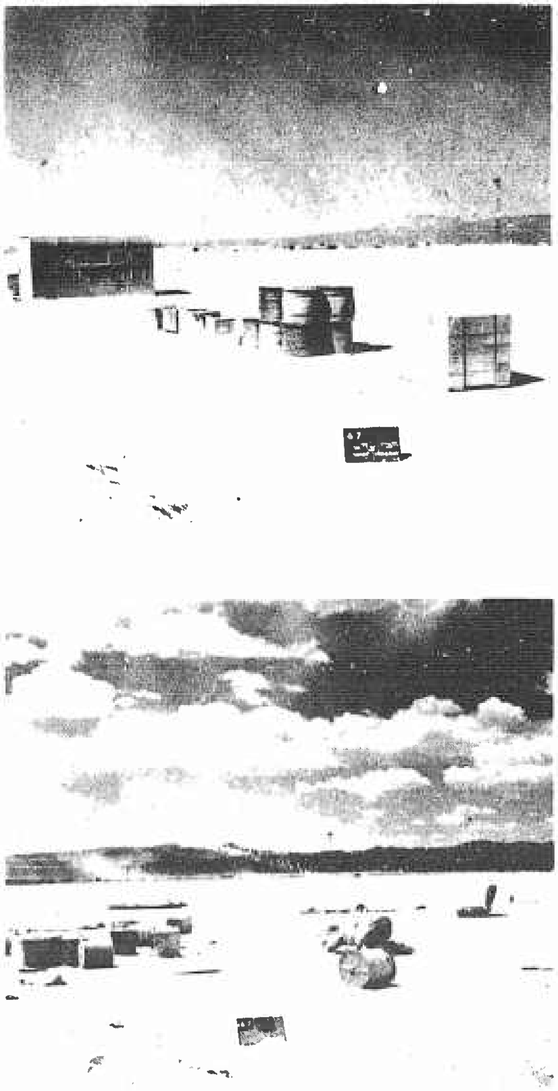


Fig. 3.136 Shot 9, Test Group 67, Signal Supply Point. (Top—before, Bottom—after). 3650 ft, 46 cal, 9.0 psi, 720 r at Surface.

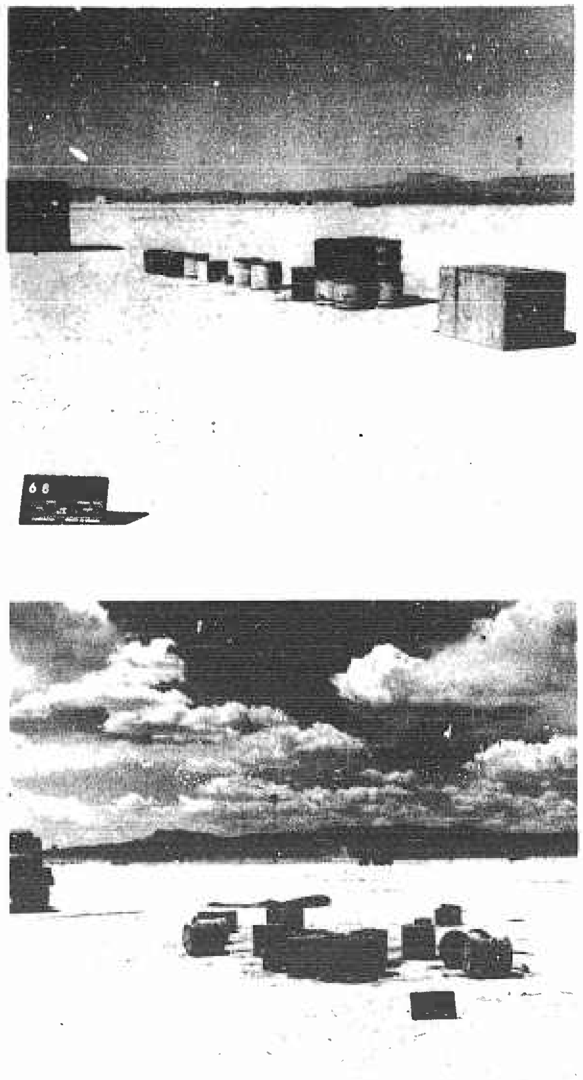


Fig. 3.137 Shot 9, Test Group 68, Signal Supply Point. (Top—before, Bottom—after) 4675 ft, 32 cal, 6.6 psi, 160 r at Surface.

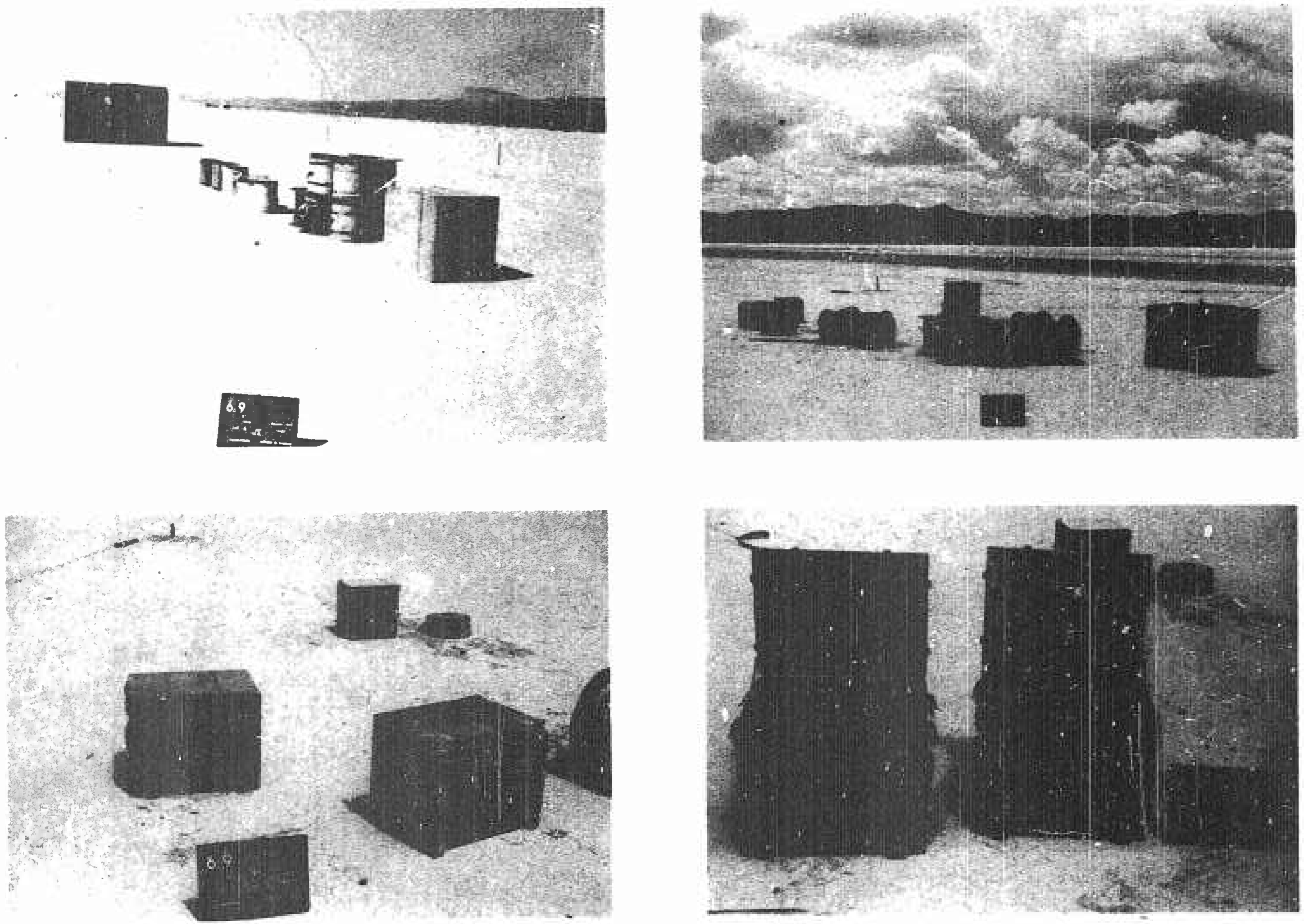


Fig. 3.138 Shot 9, Test Group 69, Signal Supply Point. (Top left-before, Top right-after, Bottom left, close-up of AN/TRC-1 Radio Set in Chests, Bottom right, close-up of AN/TRC-1 Radio Set, Chests open to Show Condition Inside.) 5625 ft, 24.5 cal, 5.4 psi, 80 r at Surface.

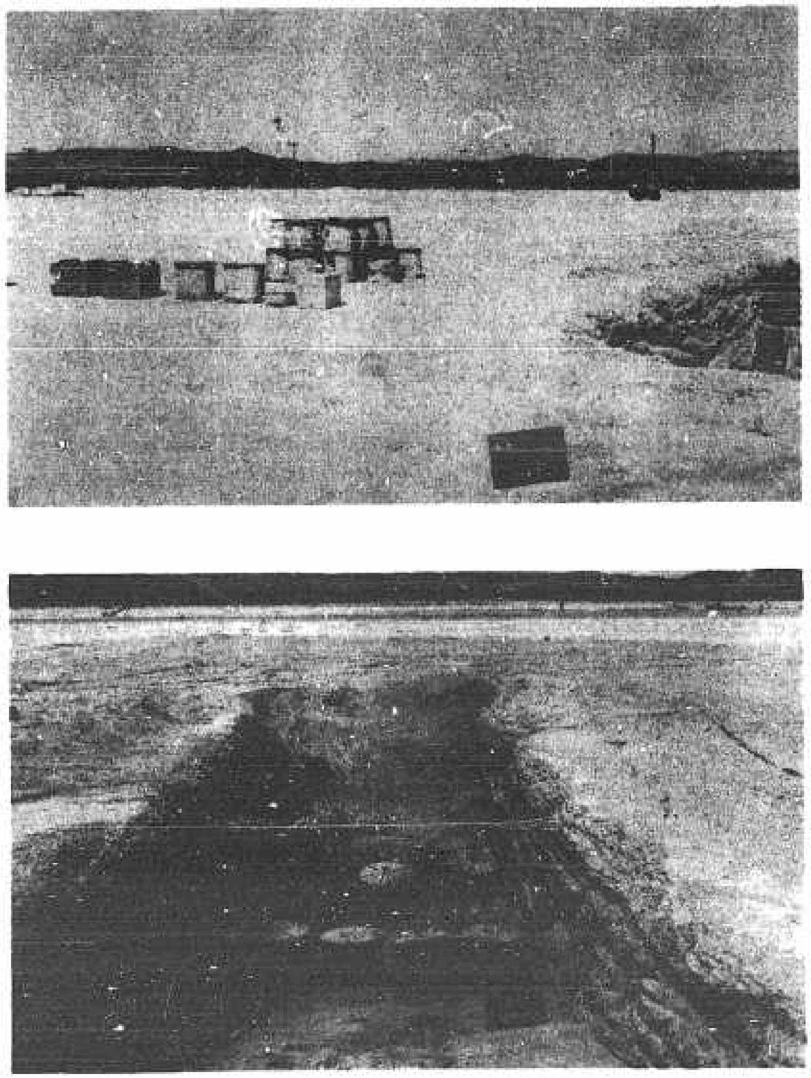


Fig. 3.139 Shot 9, Test Group 102, Signal Supply Point in Open Pit. (Top-before, Bottom-after) In Top View the Open Pit can be Seen to the Right of the Signal Supply Point on the Surface. 3150 ft, 55 cal, 10.2 psi, 1160 r at Surface.

TABLE 3.18 - Damage Summary

Shelters - Test Groups 59 Through 64, 80, and 82, Shot 9

Test Group No.	Ft from GZ	cal	psi	Surface Gamma	DAMAGE Thermal	Blast	Remarks
80*	1650	94.5	14	3680	L	S	Paint scorched on exposed exterior portions of shelter. Front end of shelter and door blown in, frame twisted, damaged beyond repair.
59**	2325	72	11.6	2440	N	S	The earth revetment provided adequate protection from thermal flux. The front end of this shelter was blown in and torn to pieces. The film badge failed and the interior gamma radiation is not known.
60	3050	57.5	10.4	1480	L	S	Exposed surface slightly scorched. Back of shelter blown out, shelter torn apart and beyond repair. The film badge not found and interior gamma radiation not known.
61	3100	56	10.4	1400	L	S	Exposed surfaces slightly scorched. Front and back blown out, sides and top crushed, beyond repair. Film badge not found, interior gamma radiation not known.
62	3650	46	9	720	L	S	Exposed surfaces lightly scorched. Shelter completely demolished.
82***	4550	33.5	6.9	200	L	S	Exposed surfaces scorched. Front blown in, top and sides crushed in beyond repair.
63	4650	32.5	6.6	160	N	S	Front blown in, top demolished, sides crushed, beyond repair.
64	5625	24	5.4	80	N	S	Front blown in, top blown in, one side crushed in, one side caved out, blown about 5 ft from original position, beyond repair.

NOTE: *Mounted on Ordnance Corps 2 1/2 ton truck.
**Revetted with front away from GZ
***Mounted in Ordnance Corps 2 1/2 ton truck.

TABLE 3.19 - Damage Summary

Signal Supply Points - Test Groups 65 Through 69, and 102, Shot 9

Test Group No.	Ft from GZ	cal	psi	Gamma*	DAMAGE Thermal	Blast	Remarks
65	1900	88.5	12.8	3160	L	L	2WD-1/TT field wire dispensers lightly scorched on GZ side. Cable reels scattered and blown from 40 to 120 ft from original position. One PE-75 packing crate broken, light damage to PE-75 power unit.
66	3150	55	10.2	1160	S	L	Several wire and cable reels caught fire and burned completely, others burned through several layers of wire on reels. One TRC-1 Transmitter burned up. Several cable reels scattered. PE-75 packing crate broken, light damage to PE-75 power unit.
102**	3150	55	10.2	1160	N	N	No thermal damage. Some of items in the pit covered with dirt, others moved about, no damage.
67	3650	46	9.0	720	N	N	No thermal damage. Reels scattered about, one PE-75 packing case broken, no damage.
68	4675	32	6.6	160	L	N	One reel W-110-B severely burned, slight scorching on other exposed items. Reels and boxes scattered to 30 ft from original positions, no damage.
69	5625	24.5	5.4	80	L	N	Reel W-110-B burned about 2 in. of wire on outer layer. Wrapping on other reels slightly scorched or burned, no damage to wire under wrappings. Some scattering of reels, no damage.

NOTE: *Initial Gamma (Roentgens)
**This supply point placed in a 4 ft deep open pit.

TABLE 3.20 - Damage Summary

Foxholes - Test Groups 70 Through 76, and 101, Shot 9

Test Group No.	Ft from GZ	cal	psi	Surface Gamma	DAMAGE Thermal	Blast	Remarks
101*	1725	90	13.6	3560	S	N	Dummies burned up. One each AN/PRC-6 and AN/PRC-10 radio set burned completely, only portions of antennas and charred chassis remained. Dirt blown in foxhole. No evidence of any blast damage.
70	1775	91.5	13.4	3400	S	N	Dummy in prone position burned up, one AN/PRC-6 radio set on dummy straps and cord severely burned, case burned but radio set operative after minor repairs. Canvas case of one EE-8 field telephone slightly burned, set operative. 8 to 10 in. dirt blown in foxhole, no damage.
71	2800	62	10.8	1760	N	N	No evidence of thermal damage to dummy or to an AN/PRC-6 radio set and EE-8 field telephone. Dummy torn apart by blast, 2 to 4 in. dirt blown in foxhole.
72	3800	44	8.6	550	N	N	Dummy prone, no thermal damage to dummy or equipment. Some dirt blown in foxhole, no damage.
73	4800	30.5	6.4	160	N	N	Some dirt blown in foxhole, no damage.
74	5800	28.5	5.2	80	S	N	Dummy caught fire and burned up. One AN/PRC-10 radio set severely burned. One EE-8 field telephone canvas case scorched but telephone not damaged. Some dirt blown in foxhole, no damage.
75	6800	16.5	4.2	20	N	N	Some dirt blown in foxhole, no damage.
76	7800	12	3.5	less than 1	N	N	Some dirt blown in foxhole, no damage.

NOTE: *High speed photography taken of this foxhole during the shot.

b. RESULTS: The dummies in Test Group 101, the foxhole at 1725 ft, 90 cal, 13.6 psi (Fig. 3.140), burned up. An examination of the high speed photography taken during the shot indicates that the intense heat caused both the dummies and the two radio sets (AN/PRC-6 and AN/PRC-9) to burn up almost instantaneously. The radio sets were destroyed by primary rather than by secondary effects.

It is of interest to observe that the dummies in foxholes along the radial pole line at 3800 ft, 44 cal, 8.6 psi (Fig. 3.144), and 4800 ft, 30.5 cal, 6.4 psi (Fig. 3.145), did not catch fire and burn. However, the dummy in the foxhole at 5800 ft, 28.5 cal, 5.2 psi (Fig. 3.146), did catch fire and burn. There is no explanation for this phenomenon except that in previous tests the thermal flux has caused no damage at a given ground range from GZ which "skipped" and has caused severe damage beyond the point where no damage occurred. One can also postulate that shielding conditions or the burning point of the materials in this particular dummy (fabric and straw) were such that burned.

The results obtained from the film badges on dummies and in foxholes were irratic and questionable. This may have been due to the fact that these film badges were placed in position three days prior to the shot or for other reasons. These film badge readings have therefore been excluded as being unreliable. A damage summary of Test Groups 70 through 76 and 101 is shown in Table 3.20.

c. PHOTOGRAPHS: Pre- and post-Shot 9 photographs of these test groups are shown in Figs. 3.140 through 3.149.

3.14 SIGNAL ITEMS IN CORPS OF ENGINEERS INSTALLATIONS — TEST GROUPS 77 THROUGH 79 (FIGS. 3.150 THROUGH 3.153)

a. DESIGN: Each of these test groups consisted of an EE-8 field telephone, an SB-22 switchboard and a hand generator GN-58A for radio set AN/GRC-9. This equipment was placed in underground command posts, company type, constructed by the Corps of Engineers. These shelters were designed to withstand the air blast of the weapon used in this test and were located at distances of 600, 900, and 4000 ft from GZ.

b. RESULTS: The Engineer type company command posts were designed to withstand the effects of the blast, and no significant damage was expected. A damage summary of these test groups is shown in Table 3.21.

c. PHOTOGRAPHS: Pre- and post-Shot 9 photographs of these test groups are shown in Figs. 3.150 through 3.153.

3.15 SIGNAL ITEMS IN MEDICAL CORPS INSTALLATIONS — TEST GROUP 83, SHOT 9 (FIGS. 3.154 AND 3.155)

a. DESIGN: Test Group 83 consisted of 2 each SB-22 switchboard, 3 each TP-6 telephone, 4 each EE-8 field telephone and 1 each 30 ft creosoted class 7 southern pine pole (for electric power distribution). One-half of the wire communications equipment was placed in a medical corps field hospital in tents on the surface and one-half of the communications equipment was installed in a similar field hospital revetted below the surface. This test group was 4125 ft from GZ.

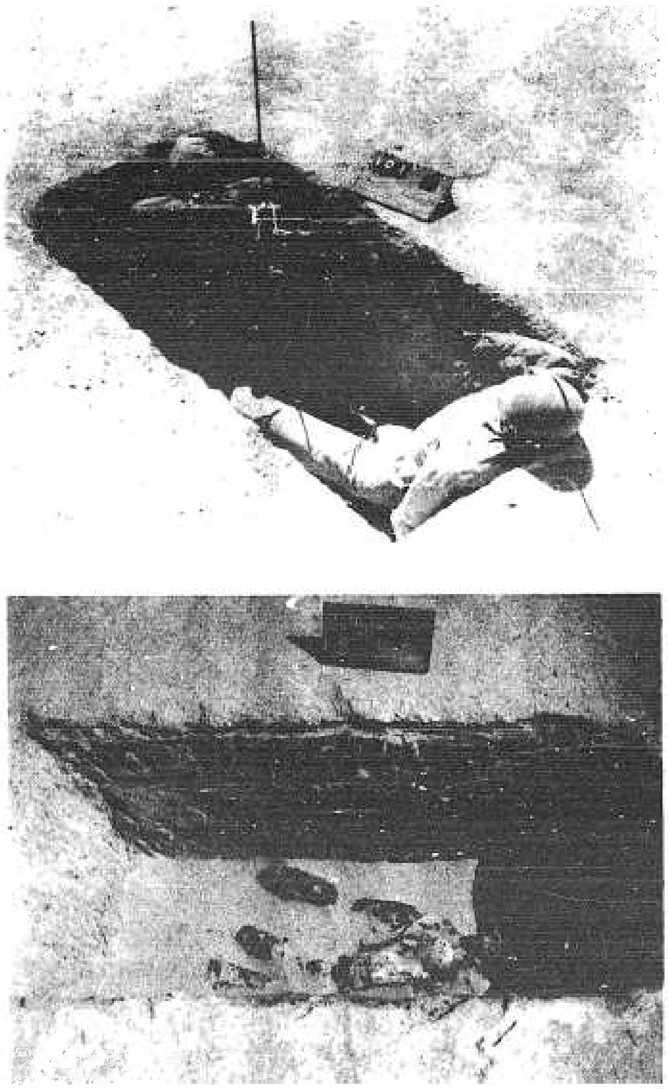


Fig. 3.140 Shot 9, Test Group 101. Foxhole with Radio Sets AN/PRC-10 on Dummies. (Top-before, Bottom-after) 1725 ft, 90 cal, 13.6 psi, 3560 r at Surface.

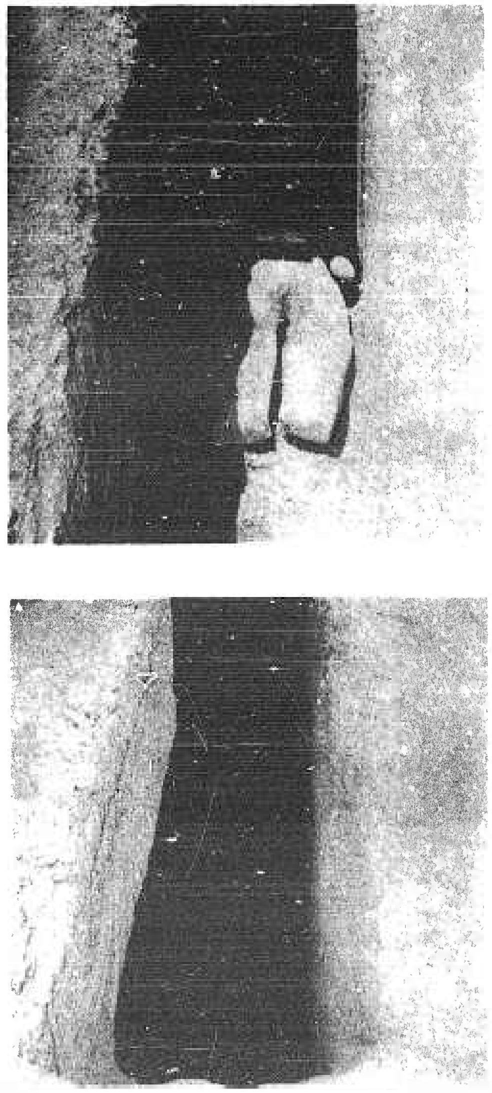


Fig. 3.141 Shot 9, Test Group 70. Foxhole with Radio Set AN/PRC-10 on Dummy. (Top-before, Bottom-after) 1775 ft, 91.5 cal, 13.4 psi, 3400 r at Surface.

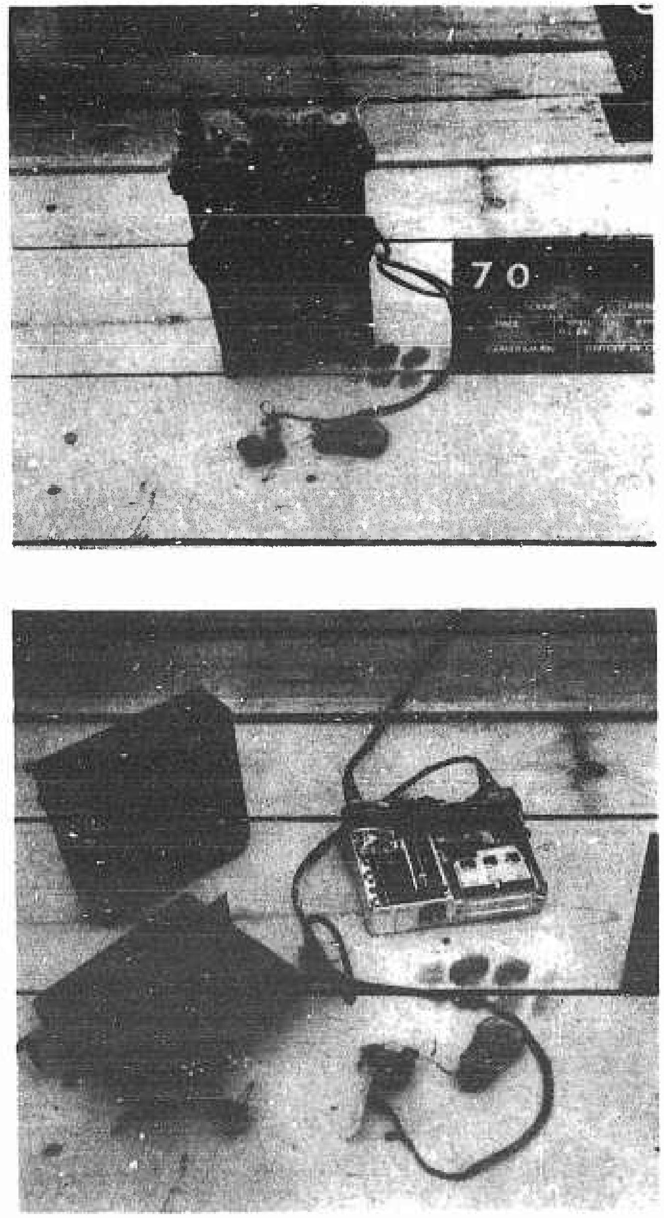


Fig. 3.142 Shot 9, Test Group 70, Radio Set AN/PRC-10 which was on Dummy in Foxhole (Fig 3.113). (Top-exterior, Bottom-Interior) 1775 ft, 91.5 cal, 13.4 psi.

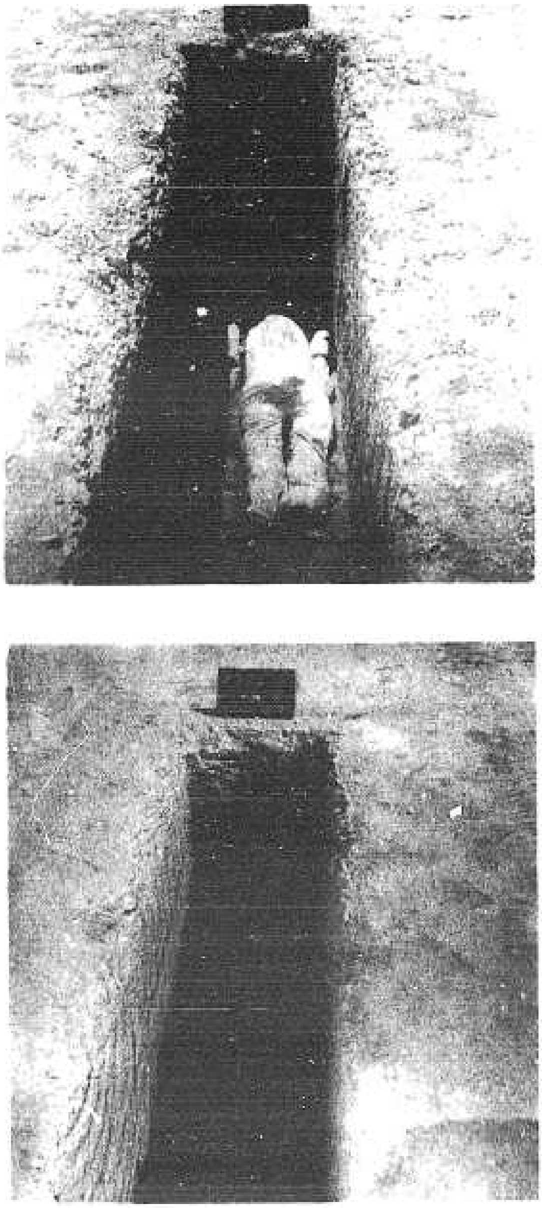


Fig. 3.143 Shot 9, Test Group 71. Foxhole with Radio Set AN/PRC-6 on Dummy. (Top-before, Bottom-after). 2800 ft, 62 cal, 10.8 psi, 1760 r at Surface.

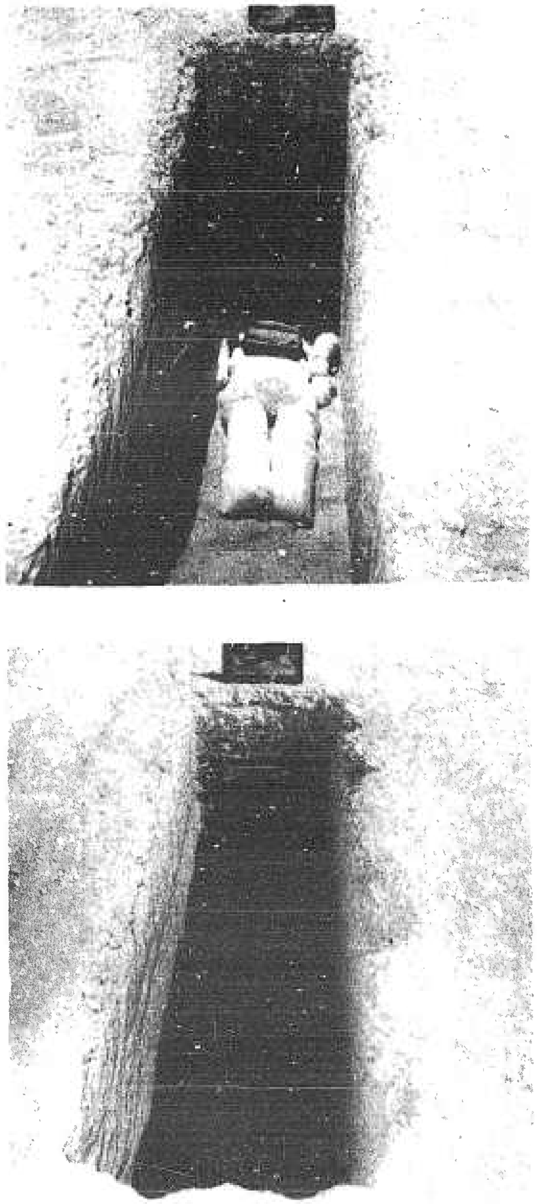


Fig. 3.144 Shot 9, Test Group 72. Foxhole with Radio Set AN/PRC-10 on dummy. (Top-before, Bottom-after). 3800 ft, 44 cal, 8.6 psi, 550 r at Surface.

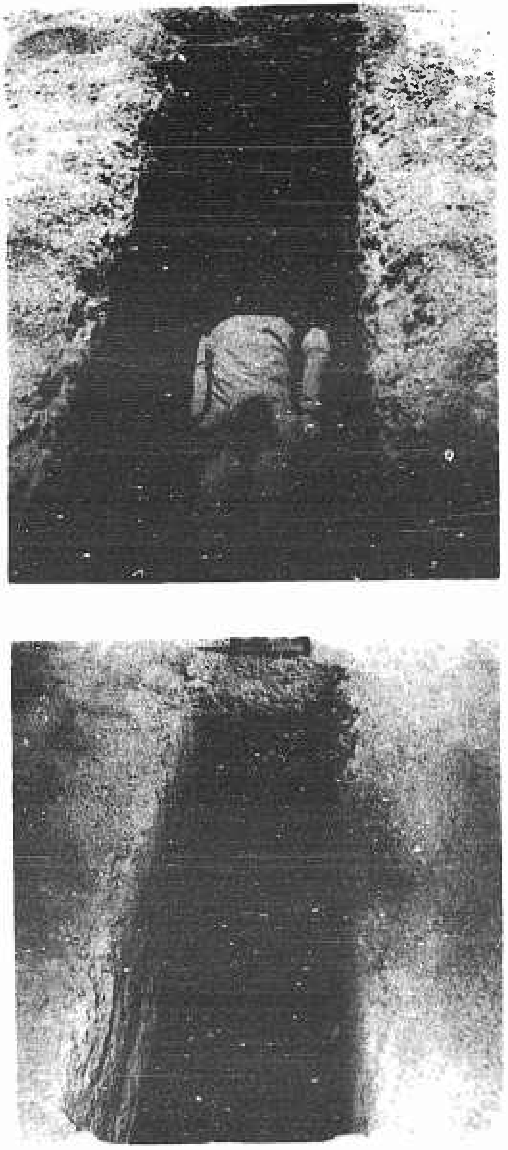


Fig. 3.145 Shot 9, Test Group 73. Foxhole with Radio Set AN/PRC-6 on Dummy and EE-8 Telephone in Foxhole. (Top-before, Bottom-after) Dummy was Moved to Sitting Position from Prone Prior to Test. 4800 ft, 30.5 cal, 6.4 psi, 160 r at Surface.

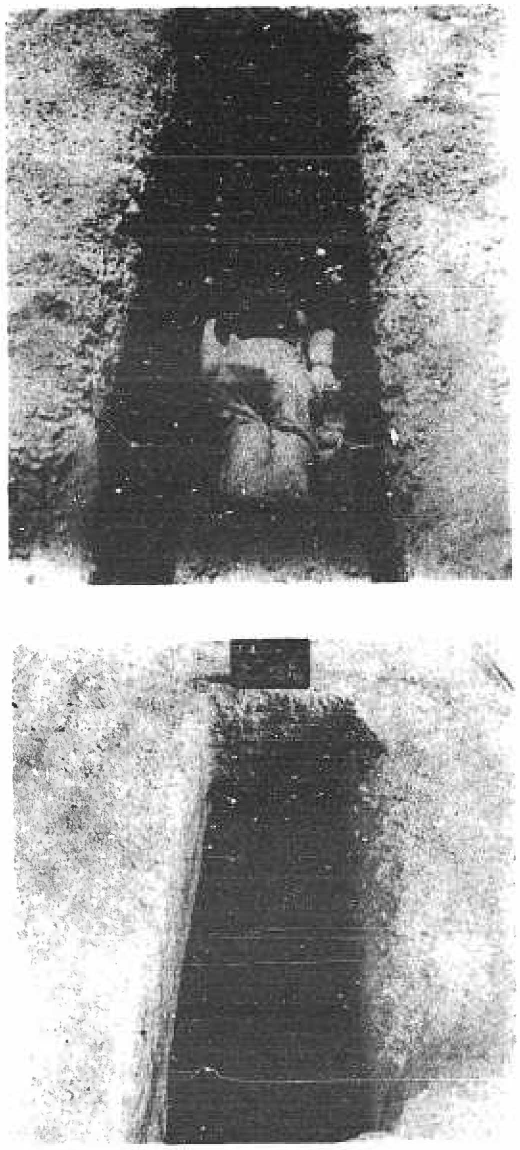


Fig. 3.146 Shot 9, Test Group 74. Foxhole with Radio Set AN/PRC-10 and Dummy and EE-8 Telephone in Foxhole. (Top-before, Bottom-after) 5800 ft, 28.5 cal, 5.2 psi, 80 r at Surface.

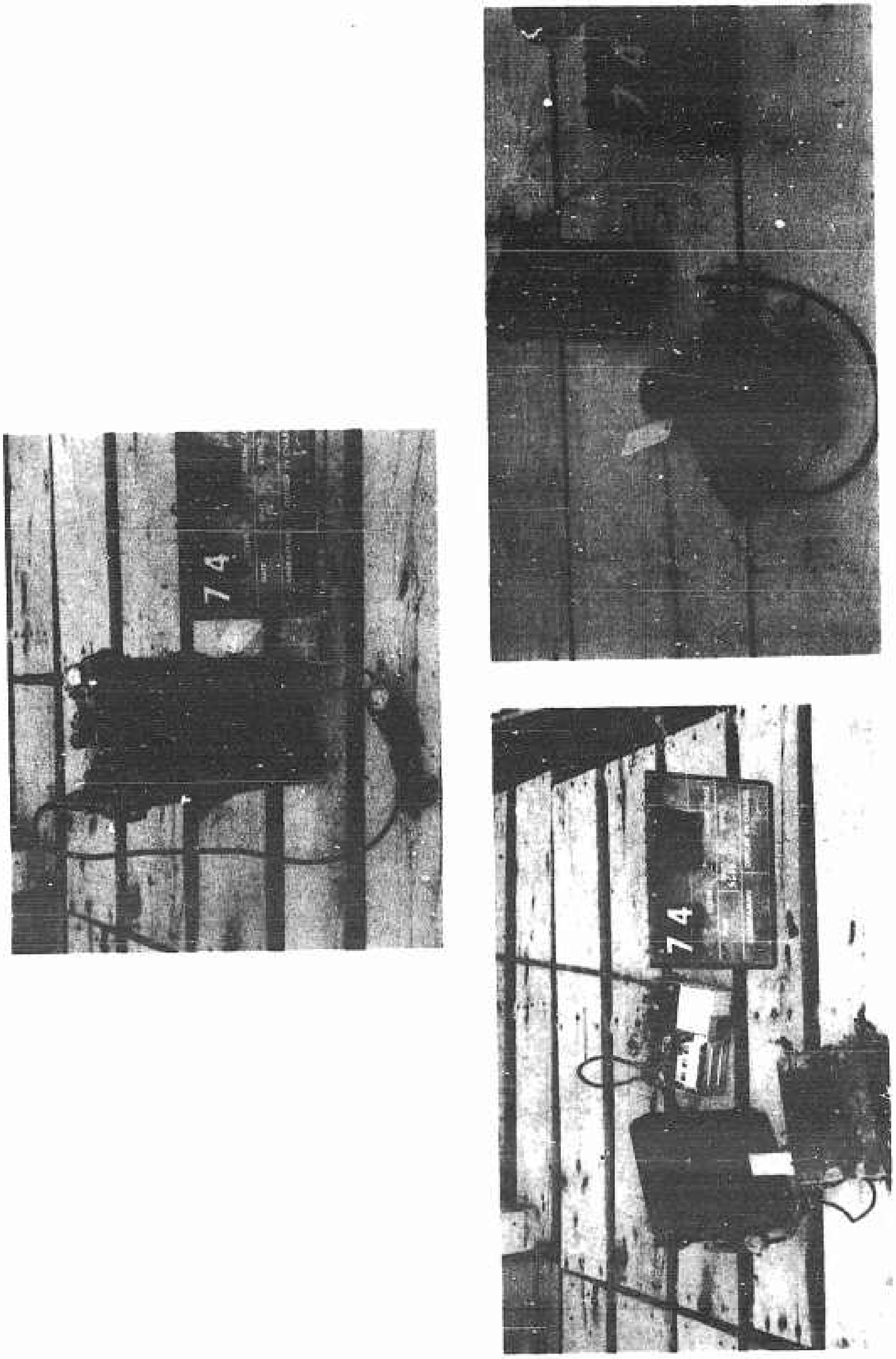


Fig. 3.147 Shot 9, Test Group 74, Radio Set AN/PRC-10 and Telephone Which were in Foxhole (Fig. 3.118). (Top-exterior, Left-interior, Right-EE-8 Telephone) 5800 ft, 28.5 cal, 5.2 psi.

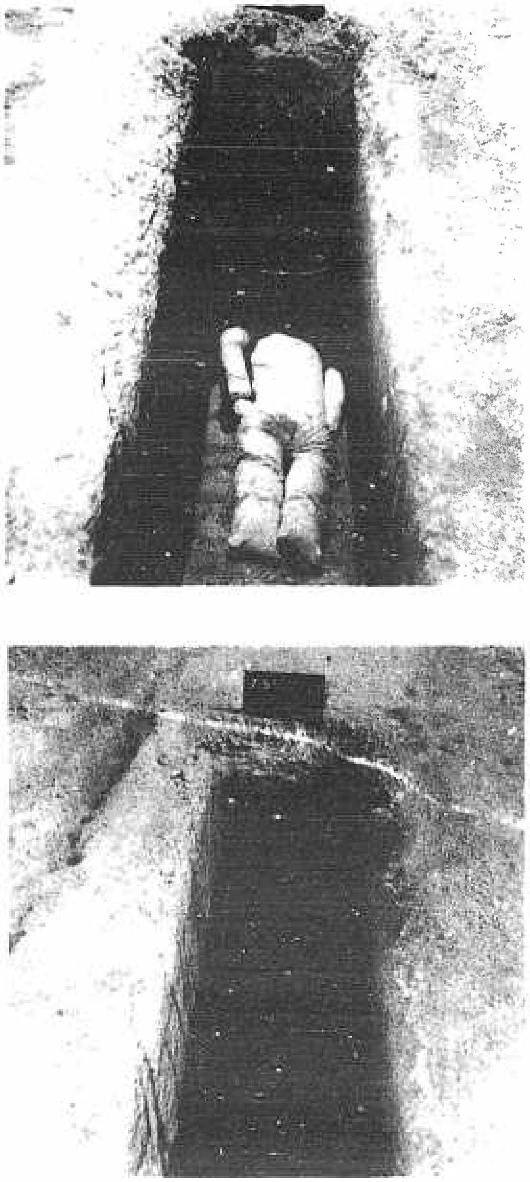


Fig. 3.148 Shot 9, Test Group 75. Foxhole with Radio Set AN/PRC-6 on Dummy and EE-8 Telephone in Foxhole. (Dummy was Moved to Sitting Position Prior to Test.) Top-before, Bottom-after. 6800 ft, 16.5 cal, 4.2 psi, 20 r at Surface.

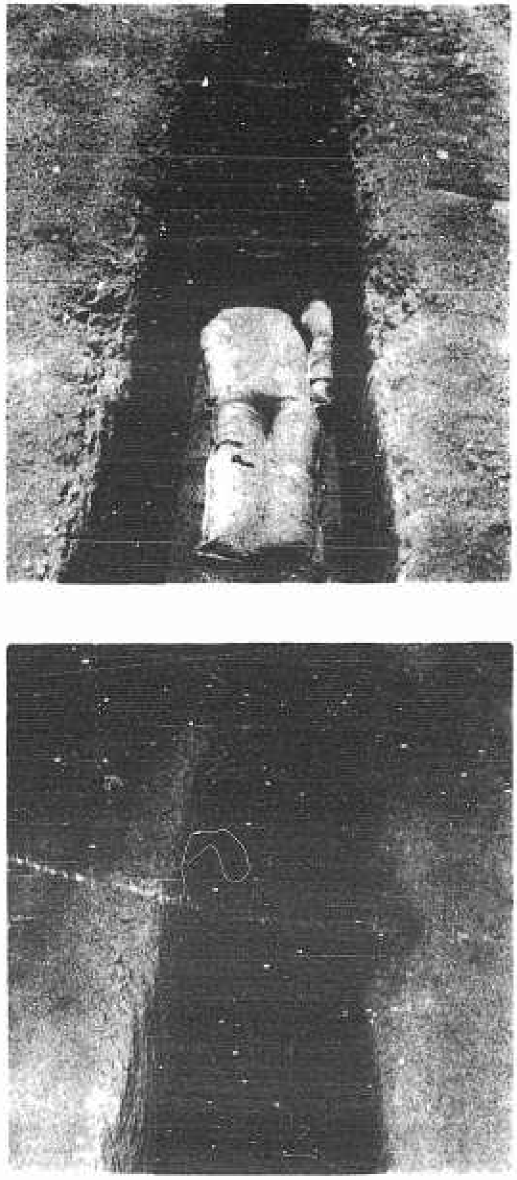


Fig. 3.149 Shot 9, Test Group 76. Foxhole with Radio Set AN/PRC-6 on Dummy and EE-8 Telephone in Foxhole. (Dummy was Moved to Sitting Position Prior to Test.) Top-before, Bottom-after. 7800 ft, 12 cal, 3.5 psi, less than 1 r at Surface.

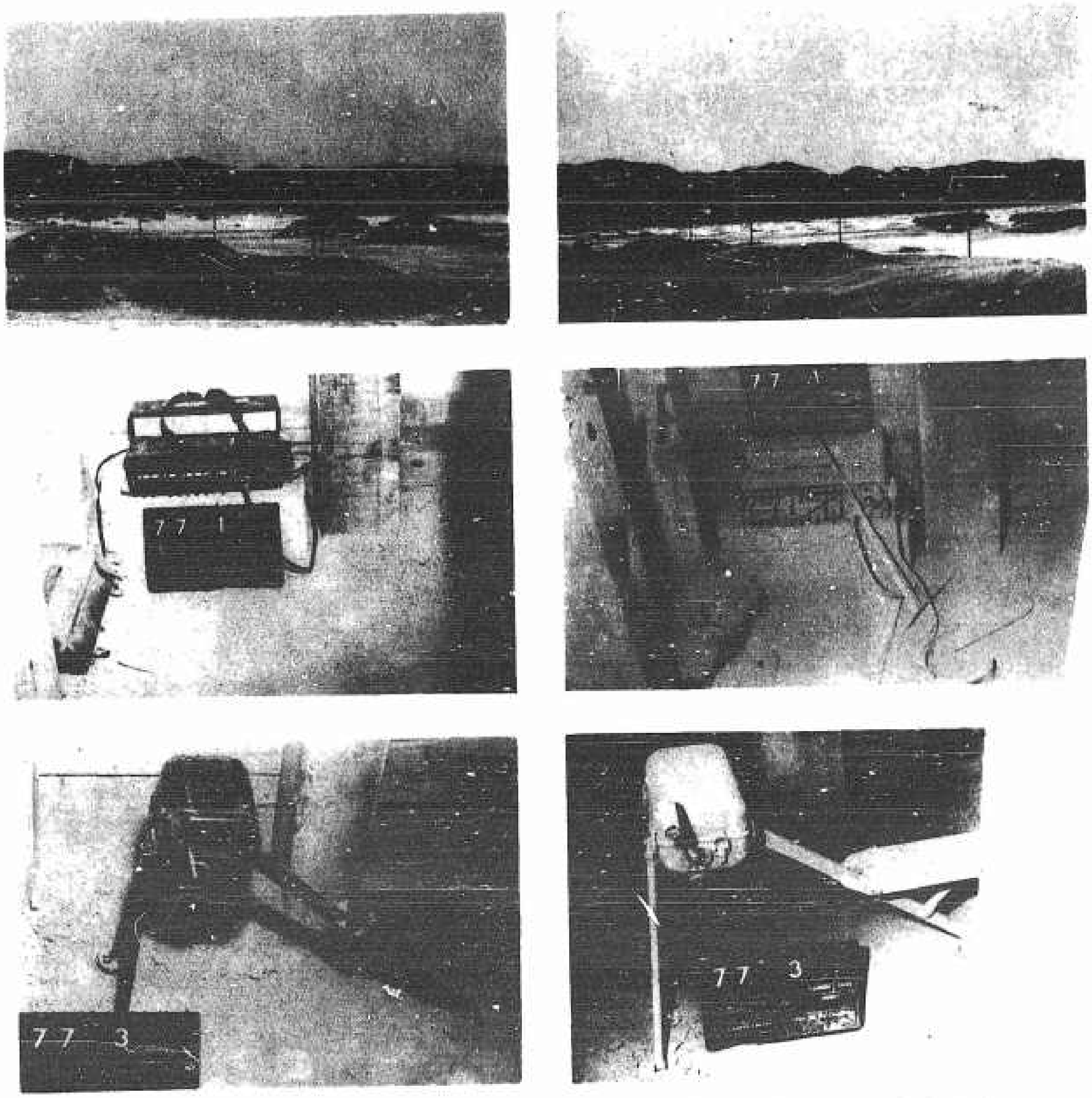


Fig. 3.150 Shot 9, Test Group 77, Signal Corps Items in Corps of Engrs. Installations (CO Type CP). (Top left-before, Top right-after; SB-22 Switchboard, Center left-before, Center right-after; GN-58A Generator, Bottom left-before, Bottom right-after.) 500 ft, over 125 cal, over 21 psi, 6400 r at Surface.

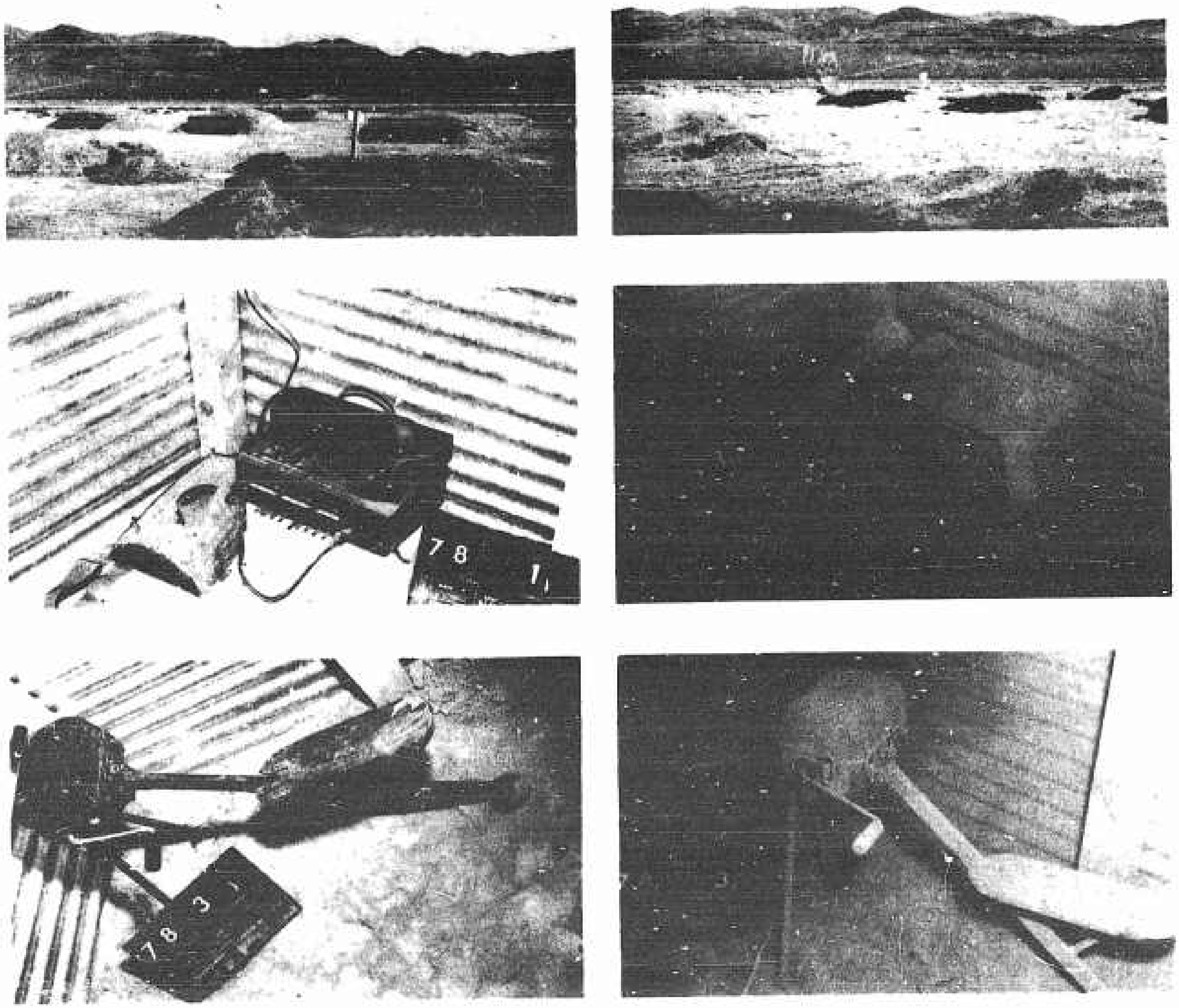


Fig. 3.151 Shot 9, Test Group 78, Signal Corps Items in Corps of Engrs. Installations (CO Type CP). (Top left-before, Top right-after; SB-22 Switchboard, Center left-before, Center right-after; GN-58A Generator, Bottom left-before, Bottom right-after.) 900 ft, over 125 cal, over 21 psi, 5400 r at Surface.

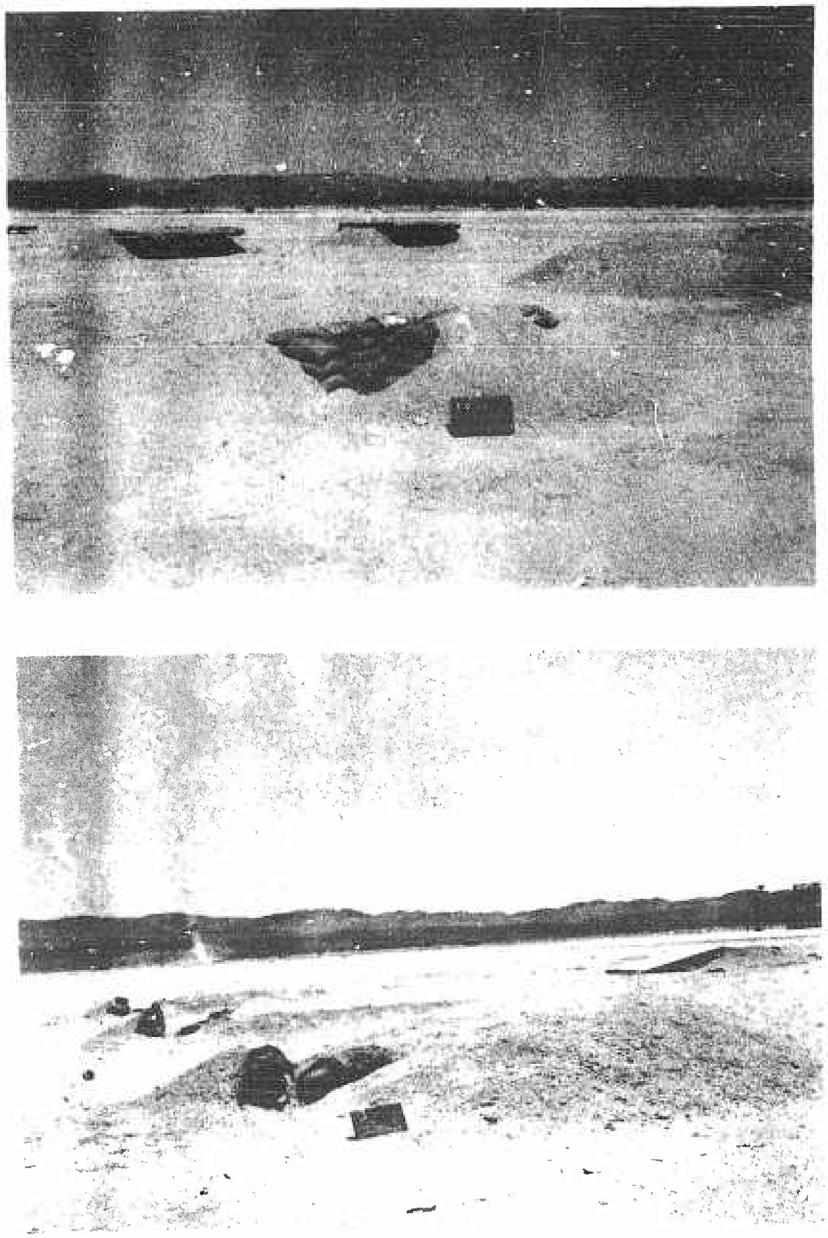


Fig. 3.152 Shot 9, Test Group 79, Signal Corps Items in Corps of Engrs. Installation (CO Type CP). (Top-before, Bottom-after) (See Fig. 3.153 for Equipment.) 4000 ft, 41 cal, 8 psi, 400 r at Surface.

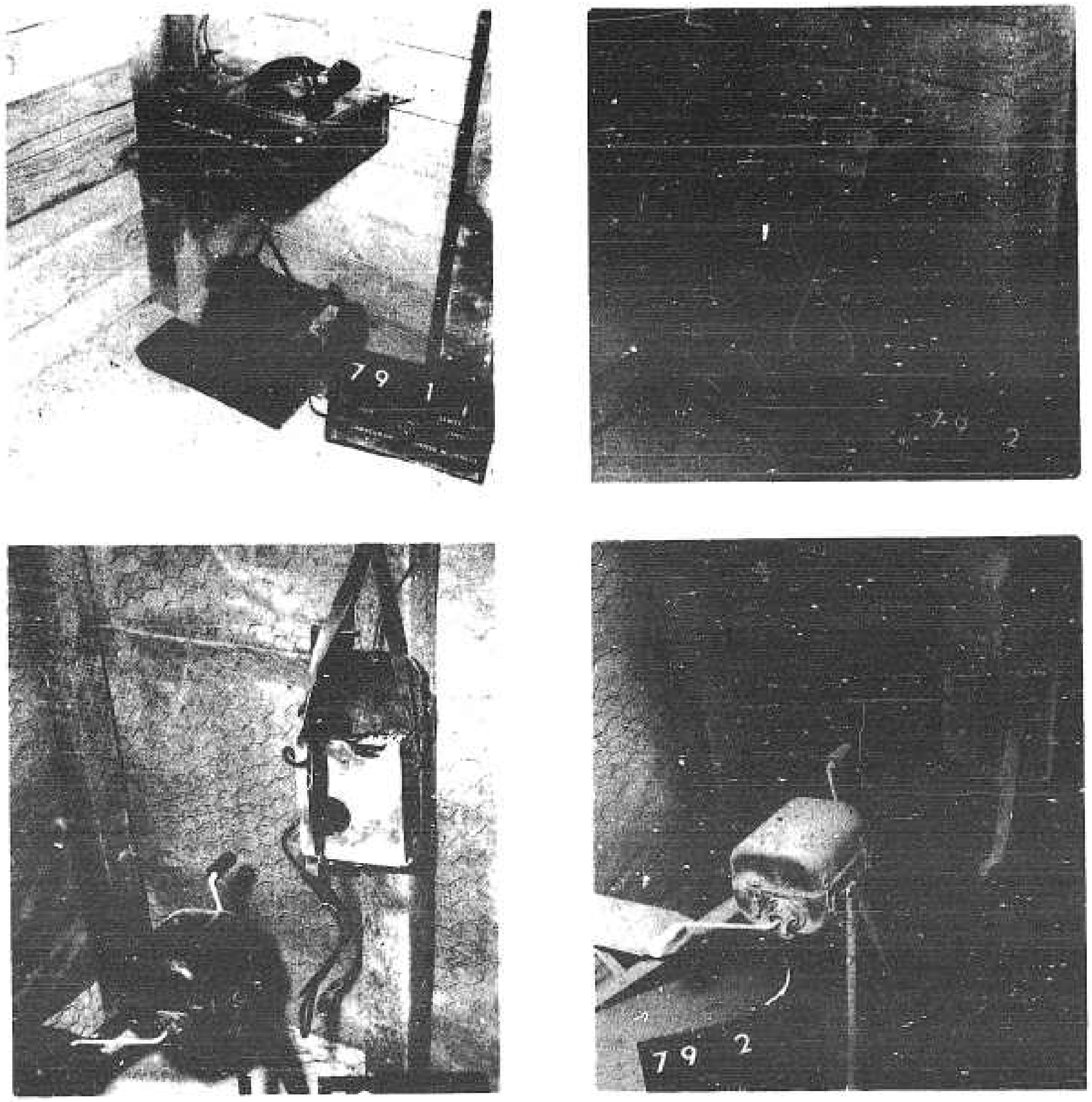


Fig. 3.153 Shot 9, Test Group 79, Signal Corps Items in Corps of Engrs. Installations (CO Type CP-Fig. 3.124). SB-22 Switchboard (Top left-before, Top right-after; GN-94 Generator and EE-8 Telephone (Bottom left-before, Bottom right-after) 4000 ft, 41 cal, 8 psi, 400 r at Surface.

TABLE 3.21 - Damage Summary

Signal Items in Corps of Engineers Installation
Test Groups 77-79, Shot 9

Test Group No.	Ft from GZ	cal	psi	Surface Gamma*	DAMAGE		Remarks
					Thermal	Blast	
77	600	over 125	over 21	6400	N	N	CP shielded from thermal damage. Dust permeated the CP and the equipment, equipment operable.
78	900	over 125	over 21	5400	N	N	CP shielded from thermal damage. Dust permeated CP and the equipment, operable.
79	4000	41	8	400	N	N	CP shielded from thermal damage. Dust permeated CP and the equipment, equipment operable.

*Initial Gamma (Roentgens)

b. RESULTS: The field hospital above and below the surface at 4125 ft, 39.5 cal, 8 psi (Fig. 3.154) caught fire and burned up. An examination of high speed photograph taken during the shot indicates that the heat caused the tent to burn from primary effects. It is extremely doubtful if the telephone equipment in the tent was damaged from primary effects. It is more plausable to believe that the heat from the tent burning caused secondary damage to the telephone equipment. The entire burning cycle is very, very rapid. A damage summary for this test group is shown in Table 3.22.

c. PHOTOGRAPHS: Pre- and post-Shot 9 photographs of this test group are shown in Figs. 3.154 and 3.155.

3.16 MANHOLES – TEST GROUPS 96 AND 96A, SHOTS 9 AND 10 (FIG. 3.156)

a. DESIGN: A cable manhole was field constructed 1250 ft from GZ on the East side of the radial pole line adjacent to pole D-52. A section of 38 in. diameter concrete tile was sunk in a hole dug in the ground. A standard cast iron manhole cover was cemented over the top of the tile. The manhole cover was about 2 inches less in diameter than the diameter of the concrete tile, therefore 2 in. x 4 in. wood was used to shore up the manhole cover. This manhole was considered to be a field expedient which served the purpose intended. A commerical type cable transfer relay together with sections of rubber-covered and lead-covered cable were placed in the manhole.

The manhole used in Shot 9 received no significant damage and was rehabilitated for Shot 10. The cable transfer relay was removed for analysis after Shot 9 and no replacement was available for Shot 10.

b. RESULTS: The manhole cover in Shot 9 (1250 ft, 113 cal, 16.6 psi), was lifted from its base and moved 1/2 in. There were several

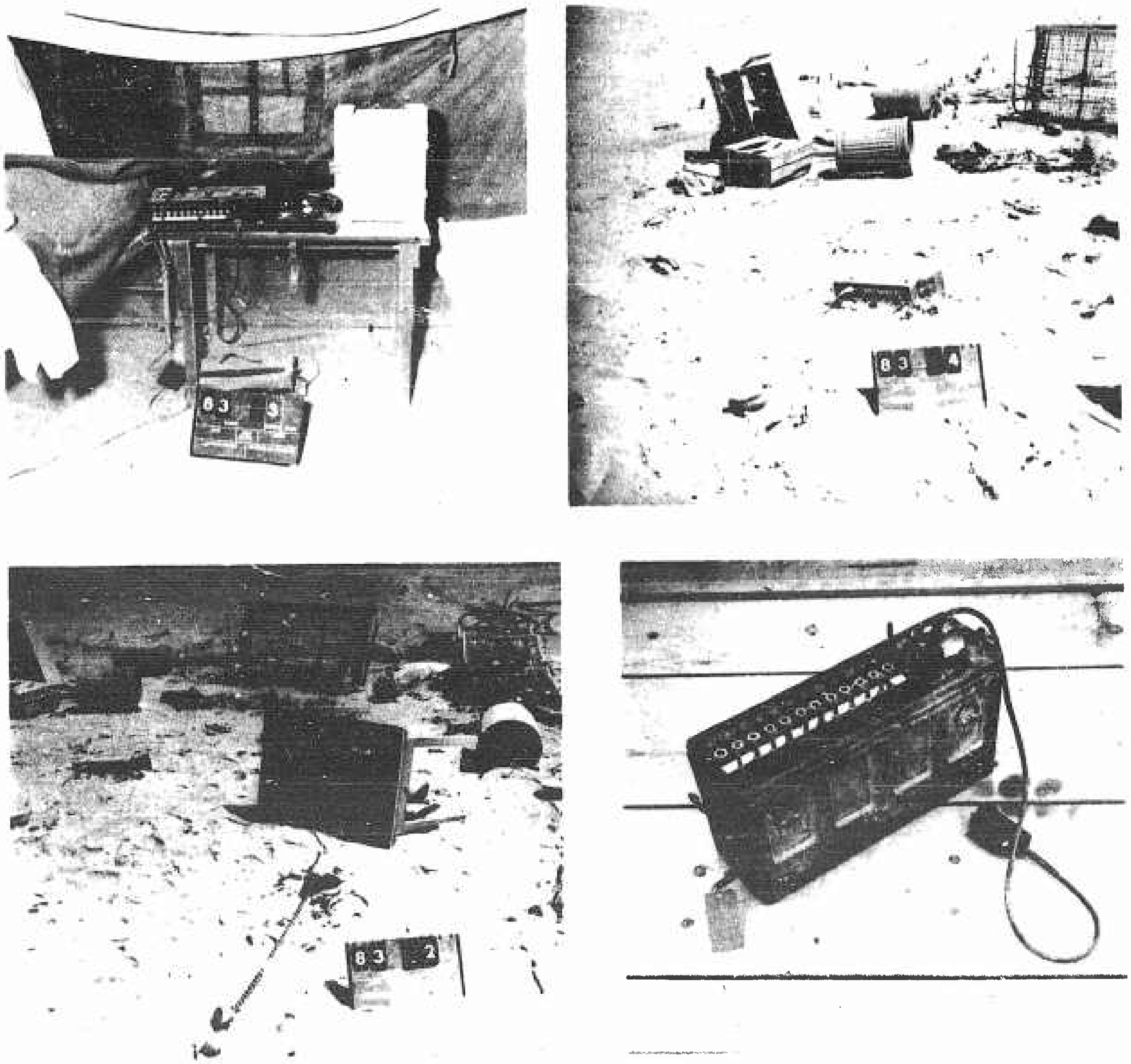


Fig. 3.154 Shot 9, Test Group 83, Signal Corps Items in Medical Corps Installations. (Field Hospital in Tents at the Surface.) (Top left-before, Bottom left-after; Top right, SB-22 Switchboard-after, Bottom right, close-up of Same Switchboard-after) 4125 ft, 39.5 cal, 8 psi, 320 r at Surface.

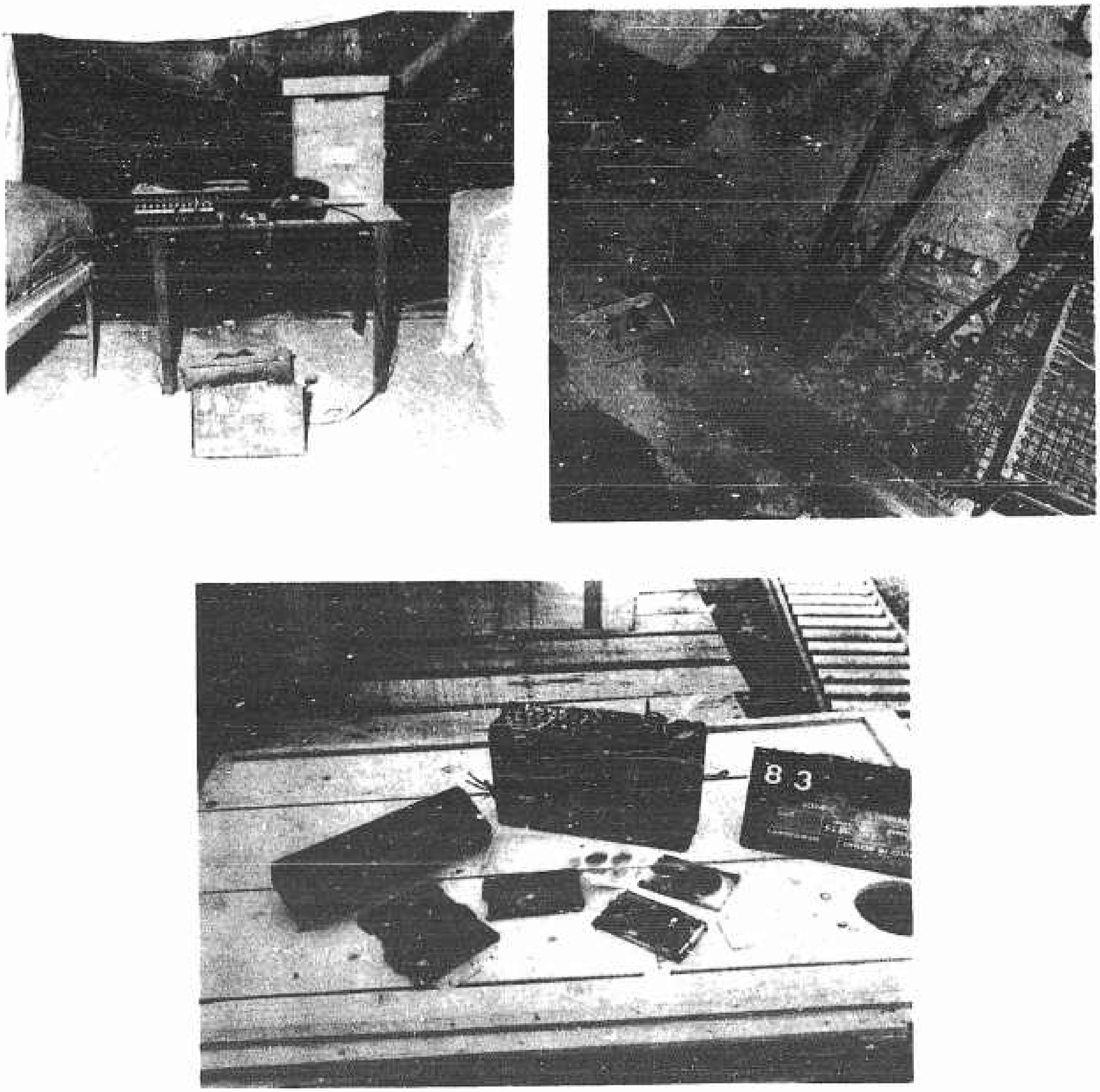


Fig. 3.155 Shot 9, Test Group 83, Signal Corps Items in Medical Corps Installations. (Field Hospital in Tents Revetted below the Surface.) (Top left-before, Top right-after, Bottom, SB-22 Switchboard-after) 4125 ft, 39.5 cal, 8 psi, 320 r at Surface.

TABLE 3.22 - Damage Summary

Signal Items in Medical Corps Installations, Test Group 83, Shot 9

Test Item	Ft from GZ	cal	psi	Surface Gamma*	DAMAGE Thermal	DAMAGE Blast	Remarks
IN TENT BELOW THE SURFACE							
SB-22 Switchboard	4125	39.5	8	320	S		Plug melted on bakelite strip, transmitter cord burned up, drop indicators melted. Switchboard thrown to ground.
TP-6 Telephone	4125	39.5	8	320	S	L	Handset, cord, induction coil and condenser completely burned. Telephone thrown to ground.
EE-8 Field Telephone	4125	39.5	8	320	S	L	Handset cord severely burned, terminals button and WD-1/TT wire melted. Telephone thrown to ground.
IN TENT ABOVE THE SURFACE							
SB-22 Switchboard	4125	39.5	8	320	L	L	Spare telephone line circuit severely burned, spare parts kit slightly burned. Thrown 300 ft from original position, one plug slightly damaged, battery case out of sockets. Case slightly damaged near ring back key. Serviceable after minor repairs made.
TP-6 Telephone	4125	39.5	8	320	L	L	Slight
EE-8 Field Telephone	4125	39.5	8	320	L	L	Slight

* Initial gamma (Roentgens)

NOTE: The QM type tents in which these items were located were completely burned up.

inches of dirt blown into the manhole but there was no apparent damage to the cable transfer relay or cable installed in manhole.

In Shot 10 the manhole cover (600 ft, over 65 cal, over 115 psi), was forced into the manhole and covered with 1-1/2 ft of earth. The manhole (field constructed) was crushed in and filled with 1-1/2 ft

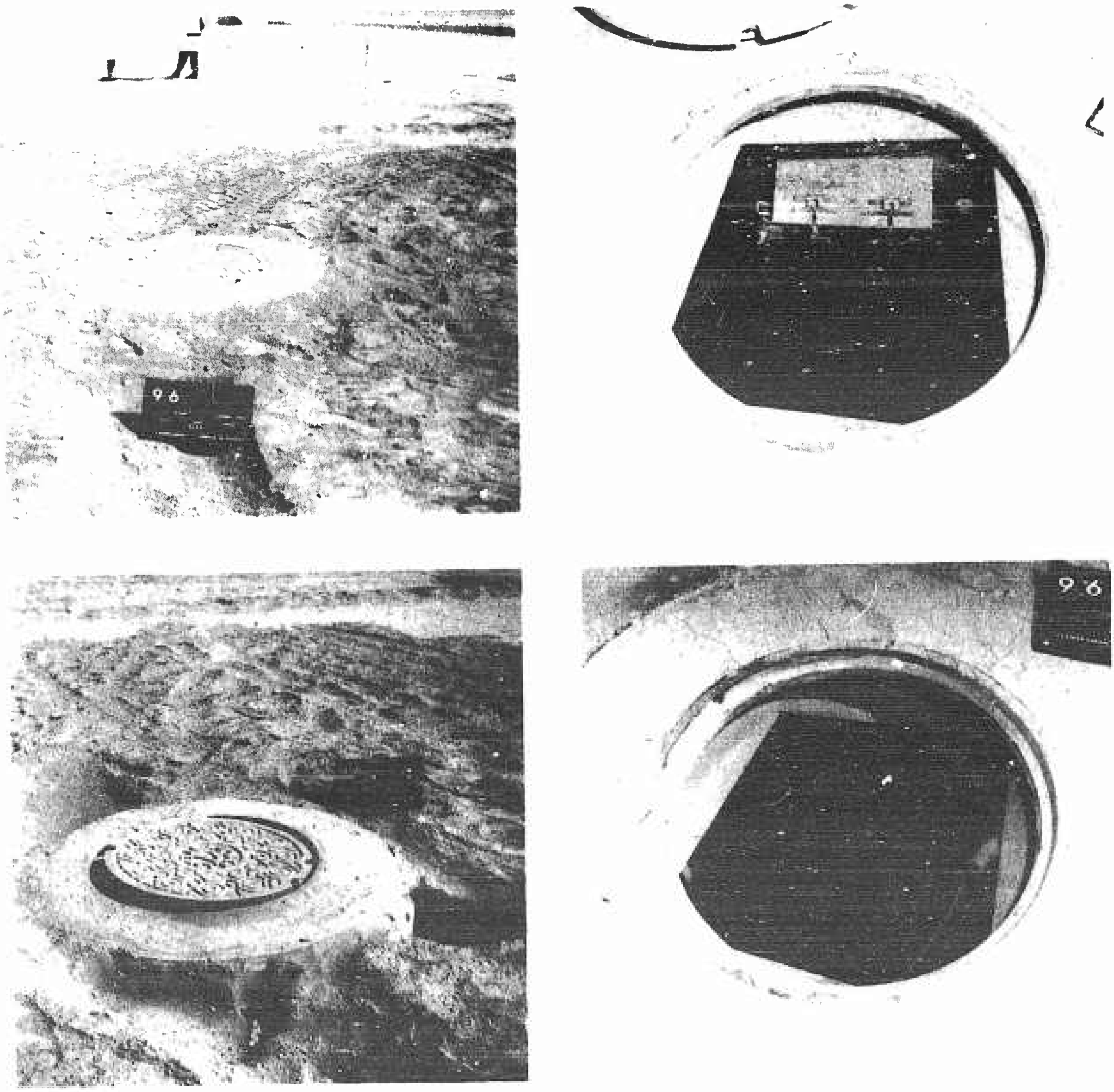


Fig. 3.156 Shots 9 and 10, Test Group 96, Manhole. (Top left-before 9, Bottom left-after 9; Interior of Manhole, Top right-before 9, Bottom right-after 9.) NOTE: The Manhole was destroyed in Shot 10. Shot 9 - 1250 ft, 113 cal, 16.6 psi. Shot 10 - 600 ft, over 65 cal, over 115 psi.

of earth. The concrete tile was intact. There was no cable transfer relay present in the manhole for Shot 10. The cable in the manhole was not damaged.

c. PHOTOGRAPHS: Pre- and post-Shots 9 and 10 photographs of these test groups are shown in Fig. 3.156.

3.17 FILM BADGES BURIED IN THE EARTH - TEST GROUPS 106 THROUGH 109, SHOT 9 (No Photographs)

a. DESIGN: Each of these test groups consisted of film badges buried in the earth at depths of 1, 2, and 3 ft. These groups were located at intervals of 1000 ft at 1775, 2800, 3775, and 4775 ft from GZ.

b. RESULTS: The results of burying film badges at 1, 2, and 3 ft below the surface are shown in Table 3.23.

TABLE 3.23 - Film Badges Buried in Containers

Gamma Radiation Attenuation in Earth, Test Groups 106-109, Shot 9

Test Group No.	Ft from GZ	cal	psi	Surface Gamma*	Film Badge Readings** 1' Depth	2' Depth	3' Depth	Reduction Ratio of Gamma Radiation 1' Depth	2' Depth	3' Depth
106	1775	91.5	13.4	3400	860	116-134	36	1/4	1/29-1/25	1/94
107	2800	62	10.8	1720	104	24	6.3	1/24	1/103	1/394
108	3775	44.5	8.8	580	106-28	3.64	.80	1/5-1/21	1/162	1/725
109	4775	30.5	6.5	160	4.35	1.08	.20	1/40	1/153	1/800

* Initial gamma at the surface (Roentgens)
** Accuracy ± 20 per cent. These readings are after the gamma radiation has passed through earth, 1/8 in. plywood and the protective covering on the film badge.

CHAPTER 4

DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

4.1 GENERAL DISCUSSION

The description of damage in this report is in accordance with definitions contained in TM 23-200, Capabilities of Atomic Weapons, paragraph 446, page 91, with one exception. For purposes of this report a category of "Negligible Damage" (N) has been added. The definitions of damage are below for purposes of ready reference.

"(1) SEVERE DAMAGE (S) - That damage which is severe enough to prevent completely the accomplishment of any useful military function, and repair of which is essentially impossible without removal to a major repair facility."

"(2) MODERATE DAMAGE (M) - That damage which is sufficient to prevent any military use until extensive repairs are effected."

"(3) LIGHT DAMAGE (L) - That damage which will not seriously interfere with immediate military operation, but will necessitate some repair to restore item to complete military usefulness."

(4) (ADDED FOR THIS REPORT ONLY) NEGLIGIBLE DAMAGE (N) - That damage which will not require any repairs to be made.

In analyzing the damage criteria for atomic weapons in accordance with the definitions set forth in TM 23-200 several deficiencies were noted in the definitions. These deficiencies are:

a. Reference the definition for SEVERE DAMAGE - This definition is not considered to be sufficiently clear. It connotes that by a removal to a major repair facility repairs can be effected. Presumably this definition was pointed toward vehicles, guns, and items which could conceivably be handled in this manner. Severely damaged buildings, structures, signal communications equipment, outside plant items and many other items are not normally handled in this manner. It is considered that the definition could be improved if it were to be rewritten substantially as follows: SEVERE DAMAGE (S) - That damage which is severe enough to prevent completely the accomplishment of any useful military function.

(1) Restoration of the severely damaged item (S) to military usefulness may be impossible and require essentially complete rehabilitation or replacement or,

(2) Require removal to, and extensive repairs at, a major repair facility.

b. The damage criteria definitions in TM 23-200 do not provide for negligible to no damage. It is considered essential that such a definition be made available. It is suggested that a definition substantially as follows be added to the list of definitions in TM 23-200, "NEGLIGIBLE DAMAGE (N) - That damage which will not require any repairs to be made."

The actual GZ for Shot 9 was 837 ft South and 15 ft West of the planned GZ. The actual GZ for Shot 10 was 139 ft South and 86 ft West of the planned GZ. These deviations did not materially affect the results obtained. They did require redrawing the layout plans using the actual GZ as the point of origin, reference Appendices A and B. This in turn resulted in distance calculations which are not always in round numbers.

In general these tests were very successful in that a damage spread ranging from severe to negligible damage was obtained for many of the items under test. This was not true in all instances. However, it is questionable whether or not further tests are essential for those items for which the spread was not obtained. The costs involved in conducting such tests, balanced against the anticipated results are unlikely to provide sufficient refinement in test results to warrant the undertaking. The above applies only to air burst implosion type atomic weapons.

It is very possible that the potentialities of atomic and other weapons systems being recognized by prospective belligerents could act to deter large scale wars in the future - at the same time sporadic local outbreaks could be incited for national reasons. On the other hand an all out atomic war could take place. It therefore appears that signal communications equipment, material, doctrine and planning must include provisions for peacetime, sporadic outbursts and an all out atomic war purposes. Presently available equipment and material and normal development will meet the first two requirements, attention must be given to the last requirement.

4.1.1 Specific Signal Communications-Electronics Equipment and Material

The damage criteria for heat (cal) as used in this report means cal/cm^2 total heat. It should be remembered that the total heat received by a given item is roughly equal to the cal/cm^2 multiplied by the exposed surface area. Although the amount of heat is large in close, the air blast which follows tends to put out any fires and somewhat nullifies the effect of the heat on so-called "hard" targets. From a heat withstanding approach most of the Signal items exposed were hard targets. Whereas with respect to blast they may or may not have been "soft" targets.

4.1.1.1 Pole Lines (Shot 9)

a. It was expected that the radial pole line would withstand greater peak overpressures than would the transverse pole lines. The

basis for this view was that for given lengths of similar pole lines the surface area exposed to the shock front, including pole and wire areas, is less for pole lines normal to the blast. The results of Shot 9 confirm this view as can be seen from an examination of the results and photographs. Discounting the thermal effects, which were negligible by comparison, the radial pole line withstood peak overpressures of from 16.6 psi to 3 psi along its length, whereas the transverse pole lines received severe damage at peak overpressures of 9.6, 7.0, and 5.6 psi respectively. The damage criteria contained in TM 23-200, reference page 97, paragraph 45b(2)(a), which states that "... 6 psi will cause severe damage, (wires and unguyed poles broken), and 3 psi will cause moderate damage, (some wire broken), in the case of 'Telephone Wire on Poles,'" requires qualification based upon the results of this test. The TM 23-200 peak overpressure damage criteria for drag sensitive targets (such as pole lines) were developed for the ideal case (i.e., no precursor or dust effects, see WT-782, Summary Report of the Technical Director) in the Mach reflection region. Under these conditions the peak overpressure uniquely defines the peak dynamic pressure and is consequently usable for describing damage effects on drag sensitive targets. Shot 9 fulfilled the first requirement adequately (ideal blast wave), but the Mach reflection region existed only at ground ranges greater than about 2500 ft, corresponding to peak overpressure less than about 11 psi. Hence, the TM 23-200 peak overpressure damage criteria for drag sensitive targets would not be applicable to ground ranges less than about 2500 ft or for peak overpressures greater than about 11 psi on Shot 9. In fact, in this regular reflection region it is well known that the dynamic pressures are less than would be calculated from the measured peak overpressure.

In Shot 9 the thermal flux and peak overpressures required to cause severe and moderate damage to a radial pole line were not determined. Nor were the thermal flux and peak overpressures required to cause severe, moderate, light and negligible damage to transverse pole lines determined.

b. CROSSARMS - None of the crossarms on the radial pole line was broken. Several crossarms on the transverse pole lines were broken.

c. INSULATOR PINS - No damage criteria were obtained for insulator pins. Since none was damaged it is evident that they will withstand greater thermal flux and peak overpressures than will other vital elements of the pole lines.

d. GLASS INSULATORS - It is not known why all of the glass insulators on the outside crossarm of pole D-52 (over 113 cal, 16.6 psi) were broken and yet none on the inside crossarm, just inches apart, were broken. It is also not known why only some of the insulators were cracked or broken in the 1000 ft section nearest to GZ on the radial pole line 113-85 cal, 16.6-13.2 psi. There were no other broken insulators on any of the pole lines. The damage could have been caused by thermal flux, peak overpressures or a combination of both.

e. TIE WIRES - There were no observed instances where tie wires broke because of thermal flux or peak overpressures.

f. GUYS AND ANCHORS - None of the four way storm guys or the triple guys were broken nor were any of the anchor rods pulled from the earth. (This also applies to the separate poles which were four way storm guyed.) These guy wires in most instances were loosened and re-tightening was all that was required.

g. JUNCTION BOXES AND TERMINAL STRIPS - There were no seriously damaged junction boxes or terminal strips. In most instances these items were shielded from the heat. The terminal strip at pole D-52 (over 113 cal, over 21 psi), although discolored, was not impaired electrically or mechanically. (It is significant to note that the top of the junction box atop Test Group 105 (over 120 cal, over 21 psi) was melted. This could cause trouble in wet weather.)

4.1.1.2 Lead Covered Cable

The lead covered aerial cable was severely damaged (lead sheath ruptured and separated) where 113-82 cal, 16.6-12.6 psi existed, yet the cable remained up on the radial pole line. It is presumed that since this damage occurred adjacent to the messenger suspension that it was caused by the peak overpressures. Whether or not the thermal flux contributed to these failures is not known. The several breakages in the 26 pair lead covered cable on the transverse pole lines where 50-35 cal, 9.6-7.0 psi existed are presumed to have been caused by the secondary effects when the poles were broken rather than by thermal flux and or peak overpressures alone. It is of interest to note that on the transverse pole line, Test Group 30, 25.5 cal, 5.6 psi, there were a sufficient number of poles standing to hold up the messenger and the cable. There was a difference of 9.5 cal, and 1.4 psi between Test Group 30 and Test Group 27.

The presumption that the cable breaks were caused by secondary effects is reinforced when it is considered that there were no cable breaks in the radial pole line and no damage to the lead covered cable on exposure boards at these values of thermal flux and peak overpressures.

4.1.1.3 Wire 104 CS (Shot 9)

This wire will withstand far greater thermal flux and peak overpressures than will the poles and crossarms on which they are strung. None of the 104 CS wire lines was broken on the radial pole line and the breaks on the transverse pole lines can be attributed to secondary effects of the poles breaking. It was not determined in this test (and it is of academic interest that it should be determined) as to what thermal flux and peak overpressures are required to cause severe, moderate, light and negligible damage to the 104 CS wire by itself. The practical damage criteria to use in this instance is that applicable to the poles and crossarms since they are more vulnerable than the 104 CS wire.

4.1.1.4 Rubber Covered Cable (Shot 9)

These cables will withstand relatively high values of thermal flux. At over 113 cal, it displayed only slight blackening and roughening on the exposed side. This same condition also obtained when the cable was laid on the surface in close proximity to GZ where the thermal flux (although shown as over 125 cal because values higher than this were not recorded) was in the vicinity of several hundred cal. There was one break in this cable on the radial pole line where 16.6 psi

existed. The cable breaks on the transverse pole line 50-35 cal, 9.6-7.0 psi are presumed to have been caused by secondary effects of the poles breaking and not directly by thermal flux and/or peak overpressures. From this test the thermal flux required to cause severe, moderate, light and no damage is therefore not known, except that it is well over 113 cal. 16.6 psi will cause severe damage to this cable strung radially and 7.0 psi will cause severe damage to this cable strung on pole lines normal to the blast. It is not known what peak overpressure is required to cause moderate or light damage. 15.4 psi caused negligible damage on the radial pole line and 5.6 psi caused negligible damage on the transverse pole line.

4.1.1.5 Spiral Four Cable

This cable will withstand slightly less values of thermal flux than will the 5 pair rubber covered cable. Although the cable jacket softened sufficiently on the radial pole line at 113-40 cal to allow slippage of the woven wire suspension clamp for several inches, removing the normal loop between clamps, there was negligible damage. The cable breaks on the transverse pole lines are attributed to secondary effects. The surface laid Spiral Four showed some burning at greater than 113 cal, how much greater is not known. The amount of thermal flux required to cause severe and moderate damage was not determined; 113 cal will cause light to no damage. It was not determined the values of psi required to cause severe, moderate, light and no damage to this cable on radial and transverse pole lines, 5.6 was still causing severe secondary damage to this cable on the transverse pole line.

Three 1/4 mile lengths of cable which extended from a point about 500 ft south of PGZ to about 3000 ft north of PGZ in a radial line parallel to the long pole line were examined. The thermal effect causing roughening of the outer jacket was observed along the entire length of cable. The jacket was destroyed, exposing the steel braid for about 100 ft either side of PGZ with no other apparent damage and this length of cable on 500 volt insulation resistance test showed about 1000 ohms and the cable is considered unusable. The two lengths of cable extending further away from PGZ indicated satisfactory IR after 72 hr immersion in water.

4.1.1.5.1 Self-Supported Spiral Four Cable

Spiral Four Cable CX-1065/G was self-supported by means of the woven wire "Economy" cable grip attached to "J" hooks on the radial pole line, extending from a point 500 ft from PGZ in a radial direction, to 8000 ft from PGZ. The 1/4 mile length starting at 500 ft from PGZ was examined at CSL. The most noticeable effect was severe abrasion to the outer jacket caused by slippage of the cable grips until the slack loop left at installation was removed. This action, however, did not destro, the usefulness of the cable and the cable could have been rehung properly by placement of the cable grips on adjacent unbraided portions of the outer jacket.

4.1.1.6 Field Wire WD-1/TT

Other than wire WD-14/TT on the exposure boards, the wire WD-1/TT proved to be the most vulnerable of all wire and cable exposed in this test. The observed damage was caused by thermal flux, although peak overpressures could have contributed to the damage after the thermal flux had weakened it. On the radial pole line greater than 16.5 cal caused severe damage, less than 16.5 cal caused light to no damage. It was not determined the values of thermal flux required to cause moderate damage. (On the surface greater than 27.5 cal caused severe damage, 27.5-16.5 cal caused moderate to light damage, and less than 16.5 cal caused negligible damage.) On the transverse pole lines 50-25.5 cal caused severe damage. It was not determined what values of thermal flux were required to cause moderate, light, and no damage on the transverse pole lines.

4.1.1.7 Underground Laid Wire and Cable

The underground wire and cable circuits suffered no damage even though they passed almost directly beneath GZ. All circuits were operable. However, the WD-1/TT wire and jumper wire above ground on the terminating pole (Test Group 105), 170 ft south of GZ were severely burned.

4.1.1.8 Separate Poles (Shot 9)

All poles sustained negligible damage. Groups 7 and 8, 3700 and 4800 ft from GZ (45 and 30 cal/cm^2) showed slight surface charring on the GZ sides of the poles. The guy wires on the side away from GZ on the guyed poles in Groups 4 and 7, 1800 and 2700 ft from GZ (13.8 and 8 psi) were loose and required tightening. All poles were serviceable.

4.1.1.9 Radio Sets in Shelters (Shot 9)

It was observed that the principal damage to the radio sets AN/GRC-26 was due to the failure of the end of the shelter S-56 which was exposed to the blast. In each instance the door and end of the shelter collapsed inwards, causing severe damage to the transmitter BC-610 and the teletypewriter equipment. Equipment in the opposite end of the shelter suffered little damage.

a. The trailers K-52 suffered considerably less damage than their associated shelters S-56. Although the power units had bent sides, hoods blown off, dead batteries and broken instrument panels, it was found that each generator could be started within 5 minutes by effecting minor temporary repairs.

4.1.1.10 Shelters (Shot 9)

The thermal effects upon all shelters were light to none; however, all shelters suffered severe damage due to blast. The peak overpressures ranged from 5 to 11 psi. The nature of the damage was similar to that experienced by Test Groups 55 through 58. The shelter

which had been modified for thermal effects, Group 60, suffered more mechanical damage than did the unmodified shelter, Group 61. This failure was due to the decreased strength of the thermal protective covering. The buried shelter, Group 59, located 2700 ft from GZ (10.8 psi and 64 cal/cm^2), received 66 r initial gamma radiation through the 24 in. of earth cover or by reflection through the end facing away from GZ. Shelters on the surface at 3100, 4600, and 5600 ft received 780, 202, and 72 r, respectively. Modified design incorporating welded structures should be investigated. Although these shelters are primarily wooden construction with canvas tops, simplified construction of aluminum should be investigated.

4.1.1.11 Vehicular Radio Sets (Shot 9)

These radio sets mounted in jeeps showed remarkable immunity to blast damage although these sets were hit by terrific blast pressures and thermal flux. These sets were operating after the blast. This was due primarily to the shielding effect of the covers and cabinets, although phenolics, plastic calibration charts were burnt or scorched.

4.1.1.12 Supply Points (Shot 9) (Fig. C.11)

The signal supply point at 3200 ft (9.2 psi and 54 cal) caught fire and burned, causing severe damage to approximately 80 per cent of the items therein. Apparently undamaged were two reels of field wire, one power unit PE-75 and one receiver AN/TRC-1, which were blown about by the blast. Equipment in other supply points suffered little or no damage. Wooden boxes were blown about somewhat by the blast and outer layers of wire WD-1/TT on reels suffered some thermal damage where it was unprotected by paper wrappings. The paper was scorched on those reels protected by paper wrappings but the wire was substantially undamaged.

4.1.1.13 Manhole (Shot 9)

The manhole cover was lifted from its base and moved 1/2 in. There were several inches of dirt in the manhole but no apparent damage to the cable transfer relay or cable installed in the manhole.

4.1.1.14 Antennas and Masts (Shot 9)

a. Equipment to be erected was primarily selected on the basis of availability. As a result, only one type of guyed tower was used. Masts used covered an excellent assortment of light duty types, no medium duty and only one heavy duty type. However, the results obtained are relatively conclusive and may be used as a guide for other types of Signal Corps antenna supports. A total of 26 antenna support installations were made located as shown on Area Plot Plan, Appendix A, identified by the Test Group Numbers 33 through 54 and 100.

b. In order to obtain damage results of from no damage to severe, installations were duplicated at intervals away from "Planned Ground Zero." The selection of site locations was based on the known

capabilities of the equipment and the predicted loads to be imposed by the blast forces. It was expected that where an installation was repeated for a total of three times, the nearest to GZ would collapse, the next might collapse, but the furthest away from GZ would remain standing.

c. To make the installations realistic, each assembly except for the tower nearest GZ was provided with an electrically non-functioning antenna for head-loading the support. In most cases the antenna used was the type normal for the support. The use of a 6 ft diameter parabolic reflector on the top of each antenna support AB-26C/CR was unique for this support. With the exception of antenna support AB-26C/CR all installations were standard for the support erected with antennas facing the predicted center of detonation (PGZ). No special precautions were taken to resist the blast forces such as extra guying, etc. Supports were oriented so that the loads would occur between two sets of guys. Instrumentation of the antenna support program to obtain accurate values of the forces to which the installations were to be subjected was not attempted. Values for peak overpressure and thermal energy were obtained from data supplied by the instrumentation programs specifically assigned to its collection.

d. The bomb detonation occurred off target, 837 ft south and 15 ft west. This increased the ground range distances as planned. Wherever given, ground range distances are taken from "Actual Ground Zero." An angle of approximately 10° was introduced between the aiming point of the antennas and antenna supports at "Planned Ground Zero" and the path of the forces from "Actual Ground Zero." This had the effect of introducing a twist in the equipment tested.

e. Blast damage was obtained ranging from severe to moderate for the tower installations; from severe to light and severe to moderate for two types of light duty masts; and from severe to a lesser degree of severity for all other type mast installations.

f. Damage by thermal radiation while decreasing in effect with increasing distance away from the blast center, produced its effects with a lesser degree of difference than the blast forces.

g. Thermal radiation caused light damage to antenna supports. Charred plastic insulators in antenna assemblies may require that the charred surfaces be cleaned or the component replaced to obtain optimum antenna performance. Where ceramic insulators are used performance should remain unimpaired. No damage to antenna equipment can be attributed to nuclear radiation.

h. The overall damage to most antenna supports and antenna equipment was greater than had been anticipated but the results were conclusive and the test successful. The damaging effects of an atomic detonation to antenna supports, antennas, and like equipment are primarily caused by the shock front and the resultant transient winds.

i. Antenna equipment designed to withstand these forces within a radius of less than one mile would be prohibitively expensive, and heavy. In most cases equipment so constructed would seriously affect its military use, particularly for lightweight portable units used in forward areas.

j. To insure the early re-establishment of radio communications in an area under atomic attack the antenna system installation should be duplicated at a sufficient distance from the initial installation as to be impervious to blast or thermal damage. To determine the

distance between installations, the antenna system in use should be evaluated in terms of the peak overpressure required to produce negligible to light damage from an optimum sized bomb burst under optimum conditions. Masts in general will withstand peak overpressures on the order of 2.5 psi. Towers in general will withstand peak overpressures on the order of 3 psi. This method may be used for any antenna system installation but is perhaps better suited to rear area permanent type structures such as self-supporting towers and antenna installations which require special erection equipment, specially trained enlisted teams, or civilian contractor personnel.

k. For intermediate area semi-permanent type installations such as guyed sectional towers and masts and forward area portable fast erecting type equipment, it would be advisable to store duplicate equipment, preferably underground, for erection at or near the damaged installation site.

4.1.1.15 Components (Shot 9)

a. Vacuum tubes - The vacuum tubes which were utilized in the equipment during these tests did not show any apparent damage. Specifically, the miniature tubes in the portable field sets showed no breaking or cracking although these sets received severe blast damage. This was due to the shadow or shielding effect.

The large transmitter type tubes, such as the 250-THs received a large amount of blast damage although the glass envelope on these tubes did not break; the elements inside were shorted. This was true in all instances up to a distance of 3000 ft from GZ.

b. Crystals - The crystals which were used in the various transmitters and radio sets as part of this experiment showed no change in frequency although they received a large initial dose of radio activity and electromagnetic radiation.

c. Capacitors - Vacuum condensers, paper condensers, electrolytic condensers and mica capacitors were not affected although a large amount of radio activity was present, and these capacitors did not check short-circuited or open-circuited.

d. Batteries - Storage batteries and dry-cell batteries were not affected although in many instances the battery packs used in the field pack radio sets received large amounts of thermal damage which melted the wax covering and made the removal of these packs impossible without scraping them out, however this had no bearing on the voltage which remained constant and was not materially affected by the thermal damage.

e. Magnetic Tape - This tape with and without intelligence showed no difference after being exposed to an atomic weapons airburst. Although large amounts of electromagnetic radiation was present these tapes showed no effects therein.

f. Loudspeakers - The large outdoor loudspeakers received severe blast damage at 1300 and 2700 ft from GZ (16-11 psi), moderate blast damage at 3700 ft (8 psi), and no apparent damage at 4700 ft or beyond that point (less than 6 psi).

Within 2000 ft of a nominal size (20 KT) atomic bomb burst, all types of loudspeakers will be damaged beyond repair insofar

as the using echelons are concerned. The efficiency, resistance to humidity and the quality of performance of any loudspeaker which remains operative will be greatly lowered. Complete replacement of the loudspeaker units will generally be required, thus precluding repairs at much lower than depot levels. Aside from the loudspeaker units, the thin sheet metal parts of horn loudspeakers may also be damaged.

g. Meters - The new "ruggedized" meters in the BC-610 transmitters suffered no apparent damage despite the fact that the transmitters themselves suffered severe blast damage. "Non-ruggedized" meters in the transmitter tuning units directly above the transmitters were broken.

h. End Items - Ringer and teletype equipment. In many instances the damage done to this equipment in the shelters was primarily due to flying or falling debris coming in contact with this equipment. Vacuum tubes, sockets and retainers apparently are able to withstand blasts of this type.

4.1.1.16 1-1/2 Mile Pole Line (Shot 10)

a. The pole line received severe damage from pole D-52, 600 ft from GZ (over 50 psi and 60 cal/cm^2) out to pole D-36, 3000 ft from GZ (6.5 psi and 45 cal/cm^2). In this section of the line 16 poles were splintered at the base of the poles, broken into one or more pieces, and scattered about the area along the pole line. There was a miscellaneous conglomeration of crossarms, pins, insulators, open wire, field wire, lead covered cable with portions of the lead sheath melted away, and rubber covered cable snarled up along this section of the pole line. (It is not known at this time if all the poles failed approximately simultaneously or whether the pole nearest GZ having failed served to produce a so-called "domino" effect. That is, when the first pole failed, releasing tension on the line, did this take tension off the poles and cause them to fail one after the other? There were separate poles at 1100 ft, 1600 ft, and 2100 ft from GZ paralleling this radial line. These separate poles included both guyed and unguyed poles. None of these poles were under line tension. All of these poles failed completely. These facts tend to discount any "domino" effect relative to the failures in the radial pole line.)

From pole D-36 out to the end of the pole line, pole D-1, 8400 ft from GZ (2 psi and 6 cal/cm^2) the damage varied from moderate to light damage to no substantial damage. Details of the damage are covered in the following breakdown according to types of circuits. These details cover only that portion of the pole line extending from pole D-36 to the far end of the pole line, pole D-1.

b. Open Wire - From pole D-36 to pole D-1 (3100 to 8350 ft from GZ) the open wire was blackened and abnormally sagged. The clearance at transposition crossovers was reduced considerably from the normal. High winds would have caused short circuits. There were several broken insulators along the line and all insulators were blackened on the GZ side. The open wire circuits would have been operable subsequent to minor repairs to this portion of the pole line.

c. 26 Pair Lead-Covered Cable - Except for some abnormal sagging this cable received no substantial damage. The lashing and messenger wire were intact.

d. Five Pair Rubber-Covered Cable CX-162/G - There was slight scorching and roughening of this cable, decreasing in intensity towards the far end of the pole line. The cable was considerably slackened from the normal but would have been operable in this section of the line. The lashing and messenger wire were intact.

e. Spiral Four Cable CX-1065/G - The spiral four cable showed some scorching and roughening, decreasing in intensity towards the far end of the pole line. There was some abnormal sag but the cable would have been operable in this section of the line.

f. Field Wire WD-1/TT - The field wire was fused, short circuited, open and badly sagged, all at intermittent points, decreasing in intensity toward the far end of the pole line. None of the wire circuits would have been operable. Complete rehabilitation of the field wire would have been required.

4.1.1.17 Surface Laid Wire and Cable (Shot 10)

The surface laid wire and cable were severely damaged from 800 ft south of GZ back to GZ and thence northerly to about 4000 ft north of GZ. The wire and cable were intermittently broken, fused, melted, and snarled up. None of the circuits were operable. From approximately 4000 ft north of GZ to the far end of the pole line, the surface laid wire and cable (except for being bunched together by the blast) received no appreciable damage.

4.1.1.18 Underground Wire and Cable (Shot 10)

The terminal ends of the underground wire and cable above ground at pole D-37, 3000 ft from GZ (6.5 psi and 45 cal/cm^2) were broken and fused and received severe damage. The same conditions were obtained at the terminal end 800 ft south of GZ (over 50 psi and over 60 cal/cm^2). The underground portions of the wire and cable lays received no apparent damage. Had not the terminal ends of the wire and cable above ground been severely damaged, these circuits would have been operable.

4.1.1.19 Display Boards (Shot 10)

These wire samples at 1000 ft from GZ on wire WD-1/TT, wire WD-14/TT Spiral Four Cable and the lead covered cable were severely damaged with conductors exposed and broken. The larger diameter cables with heavier jackets such as five pair cable, 26 pair cable, coaxial cable, and two Alpeth cables show more evidence of thermal effect than for previous samples examined but not sufficient to destroy the jacket. The samples show evidence of greater damage due to thermal and blast than samples from boards previously examined. Smaller wires and cable may be considered totally destroyed, cables such as spiral four damaged sufficiently to render useless and larger cables burned by thermal but still usable.

4.1.1.20 Separate Poles (Shot 10)

The separate poles at 280 ft, 500 ft, and 800 ft (over 50 psi and over 60 cal), at 1100 ft (40 psi and over 60 cal), at 1600 ft (12 psi and over 60 cal), and at 2100 ft (8 psi and over 60 cal) from GZ were splintered at their bases, broken into several pieces and scattered about the area. All these poles received severe damage. Poles beyond 3000 ft received very slight to no damage.

4.2 GENERAL CONCLUSIONS

The objectives of these tests have been partially but not completely accomplished.

a. In Shot 9, the amounts of peak overpressure and thermal flux required to cause severe, moderate, light and negligible damage to signal communications, electronics equipment and material were not obtained in all instances.

b. The degree of accomplishment of the objectives was very satisfactory in that much valuable data were secured which can be utilized in estimating damage and in damage analysis.

Under test conditions similar to those of Shot 9, the following can be expected:

a. Radio and wire communications within a radius of approximately one mile from GZ except buried wire and cable can be expected to receive severe damage. Buried wire and cable received no damage.

(1) This includes presently designed pole lines, radio relay towers, tactical antenna systems, fixed plant radio sets, shelters, etc.

(2) In the revetted installations, personnel and equipment, unless properly protected, will receive severe damage and casualties from secondary blast effects.

(3) The residual nuclear radiation on equipment is considered negligible and personnel can re-enter this area in 90 sec after blast.

(4) In general the damage decreases in accordance with the presently accepted criteria in TM 23-200.

Under test conditions similar to those of Shot 10, the following can be expected:

a. Radio and wire communications within a radius of 3/4 of a mile, except buried wire and cable can be expected to receive severe damage. Buried wire and cable received no damage.

(1) This includes presently designed pole lines, radio relay towers, tactical antenna systems, fixed plant radio sets, shelters, cable manholes (to at least 1000 ft), and vehicular and pack mounted radio equipment.

(2) The residual nuclear radiation on equipment and on the ground is not considered negligible and personnel cannot re-enter this area and equipment cannot be handled until permitted by the rad safe personnel. This re-entry time may be considered to be of long durations, possibly many days, especially within 1000 ft from GZ.

The information obtained from these tests will increase the knowledge of signal communications-electronics equipment and material with respect to their vulnerability to the effects of atomic weapons.

The information obtained will greatly aid in improving new design

of signal communications-electronics equipment.

Participation in future air burst atomic weapons effects tests is necessary if it is desired to secure data which are more definitive than those secured in these tests. In conjunction with such tests:

a. It appears possible to determine by laboratory methods the amounts of thermal flux required to cause severe, moderate, light and negligible damage to those items for which these data were not secured in these tests. Experiments should be conducted along these lines.

Signal Corps participation in future tests of the Shot 10 type appear to be desirable. Any firm decisions in this regard should stem from conferences with AFSWP and other interested agencies.

It is not sufficient to refer to damage criteria by end items alone in making damage analyses and in estimating damage. Consideration must be given to what effect the damage of individual end items or elements will have on the overall system. (Example: A number of radio sets, or a mile or more of open wire pole line may have received severe damage. However, if alternate means are available, or if replacements can be affected in time, the resulting damage effect upon the system must be assessed as something less than severe).

The Damage Criteria contained in Appendices E and F should be considered for inclusion in TM 23-200 and pertinent extracts thereof included in other publications.

4.3 CONCLUSIONS PERTAINING TO SPECIFIC SIGNAL COMMUNICATIONS-ELECTRONICS EQUIPMENT AND MATERIAL (SHOT 9)

Aerial wire and cable (including open wire pole lines) are relatively more susceptible to damage from thermal flux and peak overpressures than are underground and surface wire and cable. The degree of damage will range all the way from severe to negligible damage. The orientation of the pole line with respect to actual GZ is a very important factor. Pole lines normal to or approaching the normal to actual GZ can be expected to sustain greater damage than pole lines radial to actual GZ.

a. Wooden telephone poles of themselves, unguyed or guyed are not susceptible to damage from relatively large values of thermal flux or peak overpressures (discounting the results of Shot 10 for which there is as yet no satisfactory explanation). However, when these poles are in a pole line system they are very susceptible to severe damage from 5 to 6 psi. Since the action of the thermal flux on the unguyed and guyed separate poles did not cause them to break it is concluded that the thermal action had little, if any, immjdiate effect upon the poles in the pole line systems.

b. Pole line hardware such as guys, anchors, bolts, pins, tie wires, and insulators are relatively immune to thermal flux and peak overpressures. One can expect some glass insulator breakage from 6 psi and above.

c. One hundred and four steel conductors of themselves will sustain negligible damage from thermal flux and peak overpressures. However, the blast action upon the poles and crossarms will range from severe to negligible, dependent upon their orientation and the amounts of thermal

flux and peak overpressures at work. This in turn will cause the 104 CS wires to stretch and become short-circuited. Very little 104 CS wire breakage can be expected.

d. The sheaths of lead covered cable and cable risers can be expected to melt at random points, 113 to 82 cal. This melting is followed by separation of the sheaths caused by the peak overpressures. The conductors in the cable will sustain little if any damage. However, damp or wet weather would cause troubles in the cables.

e. Rubber covered cables such as 5 pair rubber covered and spiral four cables, although sustaining discoloration of the jacket have a high degree of immunity to peak overpressures and particularly thermal flux. (This is also true for the rubber on vehicles.)

f. WD-1/TT field wire is very susceptible to severe damage from thermal flux for values above 9 cal, which is comparatively low.

g. Cable transfer relays of the type tested are immune to damage from thermal flux except for the riser cables which may be melted. They are immune to other than light damage except from relatively high peak overpressures.

Surface wire and cable are relatively less susceptible to damage from peak overpressures and thermal flux than are aerial wire and cable. Their susceptibility to damage from vehicular traffic in many instances will negate this immunity advantage. There are many occasions though where their use should be continued as prescribed in current doctrine.

Underground wire and cable even at one inch depth are far less susceptible to damage from peak overpressures and thermal flux than are surface or aerial wire and cable (including open wire pole lines). The only portions of underground wire and cable which will sustain any damage are those portions which are brought above the surface for intermediate taps and terminations.

a. For protection against airburst atomic weapons effects only a slight earth cover is required, less than 1 inch.

b. For practical purposes (damage from vehicles, frost, etc.), presently prescribed tactical depths are the governing factors.

c. Because of their relatively high immunity to atomic weapons effects the desirability of increased use of appropriate types of underground wire and cable in forward combat areas should be studied.

Towers are vulnerable to severe damage from relatively low peak overpressures (on the order of 3 psi) and are subject to negligible damage from thermal flux such as paint charring. It is questionable whether the cost and weight factors involved would warrant redesign of towers for higher peak overpressures. It is quite probable that should towers be redesigned to withstand higher peak overpressures, the parabolic reflectors or antenna equipment being supported would still sustain severe damage and require replacement. The practical solution appears to be either disperse alternate towers well beyond any anticipated severe to moderate blast damaging peak overpressures, or provide spare towers and antenna equipment at readily accessible depots.

a. Tower hardware items such as anchors, guys, pulleys, winches, etc., are in most instances reusable, and complete replacements of these parts would not be required from depots.

Tactical antenna systems, masts and supports are susceptible to severe damage from relatively low peak overpressures (on the order of

2.5 psi) and subject to negligible damage from thermal flux. The practical solution to this problem is a combination of adequate replacements and dispersion beyond severe to moderate damaging peak overpressures. Since this type tactical equipment is normally designed to be erected in a relatively short time, it may be desirable in many instances to locate installations close in to any expected GZ - the predominating factor appears to be adequate readily accessible replacements.

Radio sets taken as end items are rugged and will withstand relatively high peak overpressures. They may be rendered temporarily inoperative due to antenna breakage.

a. The tactical series, radio sets AN/GRC-9, AN/PRC-6, and AN/PRC-10 will withstand high peak overpressures and still operate electronically in a satisfactory manner. Thermal flux will cause severe to negligible damage to exposed surfaces, particularly painted surfaces, light colored dials and calibration charts. There is no significant residual gamma radiation contamination on radio sets or similar equipment from a high burst atomic device.

b. The AN/GRC-26 radio sets will have broken whip antennas from about 9.4 psi up. Since they are within the S-56 shelters they are shielded from thermal flux. However, the S-56 shelter itself is very susceptible to severe blast damage and the secondary effects of this blast damage causes severe to negligible damage to the radios and other equipment within the shelter. The results obtained in this test were expected because of the planned orientation.

c. It may be possible to dig these AN/GRC-26 radio sets in sufficiently, revet, and cover them, and orient entrances in a manner similar to that employed by the Corps of Engineers for field fortifications. Such an arrangement, presenting minimum surface area to the blast forces, could conceivably withstand the blast effects, and the thermal effects would present no problem. Even though the set could be arranged so as to withstand blast and thermal effects, cognizance must be taken of the initial gamma radiation effects. Sufficient earth cover must be provided so as to reduce the initial radiation at the surface to an acceptable maximum within the shelter. Otherwise, operating personnel within the shelter (although protected from blast and heat) will have been killed or become incapacitated.

The S-56 shelters are susceptible to severe damage from relatively low peak overpressures. Since all of the shelters received severe damage it is not known what the values for peak overpressures are to cause moderate, light, and negligible damage to these shelters (as in the case of the AN/GRC-26 radio set) and the only apparent satisfactory solution to this problem is to disperse them beyond the expected extension of damaging peak overpressures or attempt to dig them in a manner similar to that employed by the Corps of Engineers for field fortifications.

a. S-56 shelters with metal tops and sides are relatively immune to thermal damage, except for paint charring or scorching which is of relatively little tactical importance at the moment of, and immediately after, an atomic burst. Shelters with fabric tops over wood are likely to burn and cause severe damage to the shelters. However, since the peak overpressures which will cause severe damage to the shelters extends

well beyond the distance the thermal flux required to burn the top extends, the peak overpressures and not the thermal flux is the criterion. The comparative weights of earth that the metal and fabric-wood tape will withstand are not known, and they should be provided with a satisfactory earth cover. This factor should be investigated.

The equipment and material in Signal Supply Points on the surface, other than being tossed and blown about by the blast, are relatively immune to peak overpressures. Their susceptibility to severe to negligible damage from thermal flux is dependent upon the composition of the material exposed to the heat. If the material has a low burning point it is likely to catch fire, and cause other material to burn. If the exposed material has a high burning point it may char from low values of thermal flux and the fires will be extinguished by the blast which follows the thermal flux. Signal supply points in open pits are not likely to have the material blown from the pits, although it may be blown around within the pit confines. The vulnerability to thermal damage is similar to that of supply points on the surface except that if the pit is deep enough it may be afforded some thermal shielding and significant blast shielding. The solution to this problem appears to be:

a. Adequate dispersion, open pits, partial protection, earth covered pits streamlined to present minimum surface areas and adequate replacements from other readily accessible supply points or depots. (Although they were not tested in this project, the impact of atomic weapons effects upon signal supply installations in various types of buildings, must not be lost sight of.) There are some applicable criteria now contained in TM 23-TM 200. Additional data should be forthcoming from other projects in these tests. It is essential that the final reports of the projects under which these tests were conducted, including the Federal Civil Defense Administration (FCDA) be studied and analyzed.

Foxholes 2 ft x 6 ft x 4 ft deep (or deeper), as stated in TM 23-200 and in other current Department of the Army doctrine will afford adequate protection from damaging peak overpressures and flying debris. At optimum distances they will afford satisfactory shielding from thermal flux and initial gamma radiation.

a. The potentialities of including suitable engineer type equipment in Signal T/O and with which to dig foxholes (and for other earth removal and earth covering purposes) should be explored. This conclusion is reached on the basis that Corps of Engineers units in most tactical echelons are likely to be called upon by all other units to do this work, all at the same time, which may over extend their capabilities. It may therefore be desirable to consider including the necessary engineer type equipment and engineer personnel organic to division signal companies, and appropriate signal units at higher echelons.

Cable manholes are immune to damage from thermal flux and are also immune to damage from other than relatively high peak overpressures. High peak overpressures may cause the manhole covers to be moved and the top casing to be blown in, although wire and cables in the manholes will receive negligible damage.

The damage to specific Signal items in Shot 10 should be studied as a matter of interest and as to the type of damage which can be expected.

4.4 CONCLUSIONS PERTAINING TO SPECIFIC SIGNAL COMMUNICATIONS-ELECTRONICS EQUIPMENT AND MATERIAL, SHOT 10

a. Aerial wire and cable (including open wire pole lines) are relatively more susceptible to damage from thermal flux and peak overpressures than are underground wire and cable. The degree of damage will range all the way from severe to no damage. At the present writing it is not known whether the orientation of the pole line with respect to actual GZ is a very important factor. Wooden telephone poles guyed or unguyed up to a distance of 3000 ft are susceptible to severe damage from relatively low values of peak overpressures. The action of thermal flux on the unguyed and guyed poles did not cause them to break.

The thermal action had little or no effect on the poles breaking up to a distance of 3000 ft from GZ but showed slight scorching beyond 3000 to 4000 ft from GZ.

b. Pole line hardware such as guys, poles, pins, tie wire, and insulators are relatively immune to the thermal flux action received. Severe damage to equipment from blast will result up to a distance of 3000 ft from GZ with relatively low overpressures.

c. One hundred and four steel wire will receive severe damage to a distance of 3000 ft from GZ.

d. Lead covered cable is susceptible to severe damage from large amounts of thermal flux up to a distance of 3000 ft from GZ. It can be expected to melt and leave the conductors exposed. Also the blast will snarl up all cable to a distance of 3000 ft causing short circuits. Reuse is impossible.

e. Rubber covered cables such as 5 pair and spiral 4 cable will sustain severe thermal flux damage. The jackets will be ruptured leaving the conductors exposed up to a distance of 3000 ft from GZ. Damp weather would cause trouble with these cables.

f. Wire WD-1/TT, field wire, is very susceptible to severe damage from thermal flux up to a distance of 3000 ft from GZ and cannot be reused.

g. Surface wire and cables are relatively more susceptible to damage from thermal flux and low peak overpressures than any given amounts in Shot 9. The jackets on the cables will receive large amounts of burning and the cable will be broken and snarled due to low peak overpressures.

h. Underground wire and cable even only at 1 inch depth are far less susceptible to damage from peak overpressures and thermal flux than are surface or aerial wire and cable. The only portion of underground wire and cable which will sustain any damage are those portions which are brought above the surface for taps and terminations.

i. Separate poles. Poles guyed or unguyed, class 7 and class 3, are very susceptible to damage from relatively low peak overpressures up to a distance of 3000 ft. Beyond 3000 ft the damage is negligible.

4.5 RECOMMENDATIONS

It is recommended that:

a. Signal Corps pay particular heed to the immunity displayed by buried circuits to atomic weapons detonations, and determine how best to

use this information in planning tactical communications installations.

b. The possibility of utilizing laboratory methods to determine the desired thermal flux and peak overpressures effects on Signal Communications-Electronics equipment and material in lieu of costly atomic test programs be investigated.

APPENDIX A

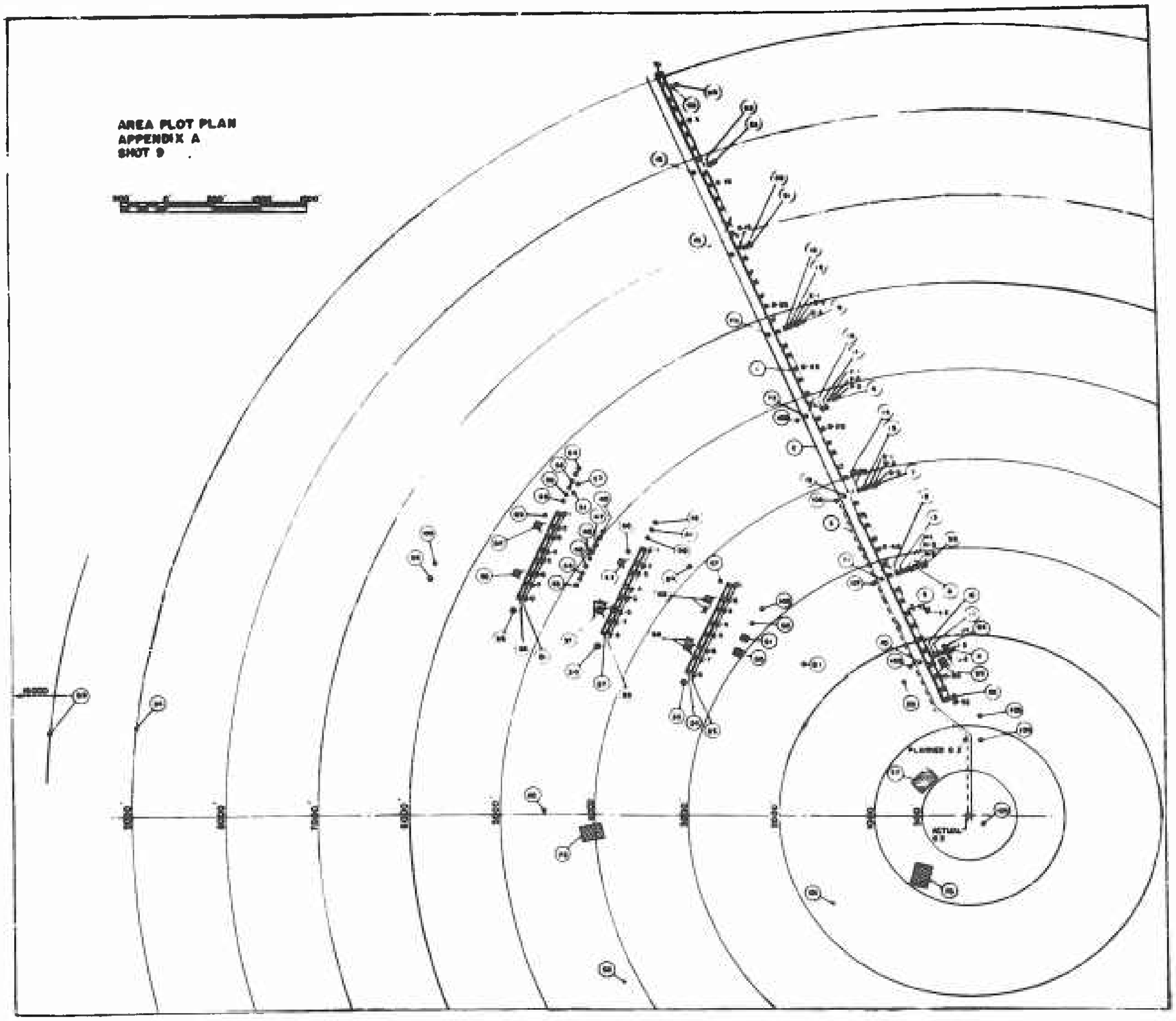


Fig. A.1 Area Plot Plan, Shot 9

TABLE A.1 - Legend, Shot 9

Test Group	*Description	Distance from GZ (ft)	cal	psi
1	Radial pole line	1250-9080	113-8	16.6-3
2	Surface wire and cable along the radial pole line thru GZ to 175 ft south of GZ	9080N-170S	8-Over 120	3-Over 21
3	Underground wire and cable along the radial pole line thru GZ to 175 ft south of GZ	3750N-175S	44.5-Over 120	8.8-Over 21
4	Three separate poles	1850	85	13.2
5	One separate pole	2350	72	11.4
6	Three separate poles	2825	61.5	10.8
7	Three separate poles	3825	43.5	8.6
8	Two separate poles	4875	30.5	6.2
9	Three separate poles	5800	23.5	5.2
10	Exposure Board	1825	88	13.2
11	Exposure Board	1825	88	13.2
12	Exposure Board	2800	62	10.8
13	Exposure Board	2800	62	10.8
14	Exposure Board	3825	43.5	8.6
15	Exposure Board	3825	43.5	8.6
16	Exposure Board	4800	30.5	6.4
17	Exposure Board	4800	30.5	6.4
18	Exposure Board	5800	23.5	5.2
19	Exposure Board	5800	23.5	5.2
20	Exposure Board	6800	16.5	4.2
21	Exposure Board	6800	16.5	4.2
22	Exposure Board	7800	10.8	3.4
23	Exposure Board	7800	10.8	3.4
24	1050 ft open wire transverse pole line	3425	50	9.6
25 26	Surface wire and cable along the transverse pole line	3400	50	9.6
27	1050 ft open wire transverse pole line	4450	35	7.0
28	Surface wire and cable along transverse pole line	4450	35	7.0
29	Not used			
30	1050 ft open wire transverse pole line	5425	25.5	5.6
31	Surface wire and cable along transverse pole line	5425	25.5	5.6
32	Not used			
33	Large tower (120 ft high)	3350	51.5	9.8
34	Large tower (120 ft high)	4350	36	7.2
35	Large tower (120 ft high)	5350	26	5.6

* For description of equipment see Appendix G

TABLE A.1 - Legend, Shot 9 (Continued)

Test Group	*Description	Distance from GZ (ft)	cal	psi
36	Large tower (200 ft high)	6350	19.5	4.6
37	Not used			
38	Not used			
39	Antenna Mast AB-26/CR	4050	40.5	8
40	Antenna Mast AB-26/CR	4600	32.5	6.8
41	Antenna Mast AB-224/U	4625	32.5	6.8
42	Antenna Mast AS-19/TRC-1	4650	32.5	6.8
43	Antenna Mast AS-19/TRC-1	4900	29.5	6.2
44	Antenna Mast AB-155/U	4900	29.5	6.2
45	Antenna Mast Lightweight	4925	29.5	6.2
46	Antenna Mast Lightweight	4950	29.5	6.2
47	Antenna Mast AN-GRC-4	5000	28.5	6.0
48	Antenna Mast AN-GRA-4	5000	28.5	6.0
49	Antenna Mast AB-26/CR	5550	25	5.4
50	Antenna Mast AB-224/U	5575	25	5.4
51	Antenna Mast Lightweight	5550	25	5.4
52	Antenna Mast AB-155/U	5625	24.5	5.3
53	Antenna Mast Lightweight	5575	24.5	5.4
54	Antenna Mast AB-155/U	5675	24	5.3
55	Radio Set AN/GRC-26 (revetted)	1700	91	13.8
56	Radio Set AN/GRC-26 (revetted)	3500	49	9.4
57	Radio Set AN/GRC-26 (revetted)	4500	34	7.0
58	Radio Set AN/GRC-26 (revetted)	5500	25	5.6
59	S-56 Shelter (revetted)	2325	72	11.6
60	S-56 Shelter (modified) (surface)	3050	57.5	10.4
61	S-56 Shelter (standard) (surface)	3100	56	10.4
62	S-56 Shelter (surface)	3650	46	9.0
63	S-56 Shelter (surface)	4650	32.5	6.6
64	S-56 Shelter (surface)	5625	24	5.4
65	Signal Supply Point (surface)	1900	88.5	12.8
66	Signal Supply Point (surface)	3150	55	10.2
67	Signal Supply Point (surface)	3650	46	9.0
68	Signal Supply Point (surface)	4675	32	6.6
69	Signal Supply Point (surface)	5625	24.5	5.4
70	Foxhole 2 ft x 6 ft x 4 ft deep	1775	91.5	13.4
71	Foxhole 2 ft x 6 ft x 4 ft deep	2800	62	10.8
72	Foxhole 2 ft x 6 ft x 4 ft deep	3800	44	8.6
73	Foxhole 2 ft x 6 ft x 4 ft deep	4800	30.5	6.4
74	Foxhole 2 ft x 6 ft x 4 ft deep	5800	28.5	5.2
75	Foxhole 2 ft x 6 ft x 4 ft deep	6800	16.5	4.2
76	Foxhole 2 ft x 6 ft x 4 ft deep	7800	12	3.5
77	Signal items in Engr Instns	600	Over 125	Over 21

* For description of equipment see Appendix G

TABLE A.1 - Legend, Shot 9 (Continued)

Test Group	*Description	Distance from GZ (ft)	cal	psi
78	Signal items in Engr Instns	900	Over 125	Over 21
79	Signal items in Engr Instns	4000	41	8
80	Signal items in Ord Vehicles	1650	94.5	14
81	Signal items in Ord Vehicles	2425	58.5	10.6
82	Signal items in Ord Vehicles	4450	33.5	6.9
83	Signal items in Med Instns	4125	39.5	8
84	Signal items in Med Instns	9000	8.5	3
85	Signal items in Med Instns	15000	Less than 1	Less than 1
86-95	Not used			
96	Manhole (field constructed)	1250	113	16.6
97	Not used			
98	Exposure Board	8800	9.5	3.0
99	Exposure Board	8800	9.5	3.0
100	Antenna Mast AB-155/U	6350	19.5	4.6
101	Foxhole 2 ft x 6 ft x 4 ft deep	1725	90	13.6
102	Signal Supply Point (below surface)	3150	55	10.2
103	One separate pole	1150	120	17.8
104	One separate pole	850	Over 120	Over 21
105	One separate pole	175	Over 120	Over 21
106	Film Badges in containers buried 1 ft, 2 ft, and 3 ft	1775	91.5	13.4
107	Film Badges in containers buried 1 ft, 2 ft, and 3 ft	2800	62	10.8
108	Film Badges in containers buried 1 ft, 2 ft, and 3 ft	3775	44.5	8.8
109	Film Badges in containers buried 1 ft, 2 ft, and 3 ft	4775	30.5	6.5

* For description of equipment see Appendix G

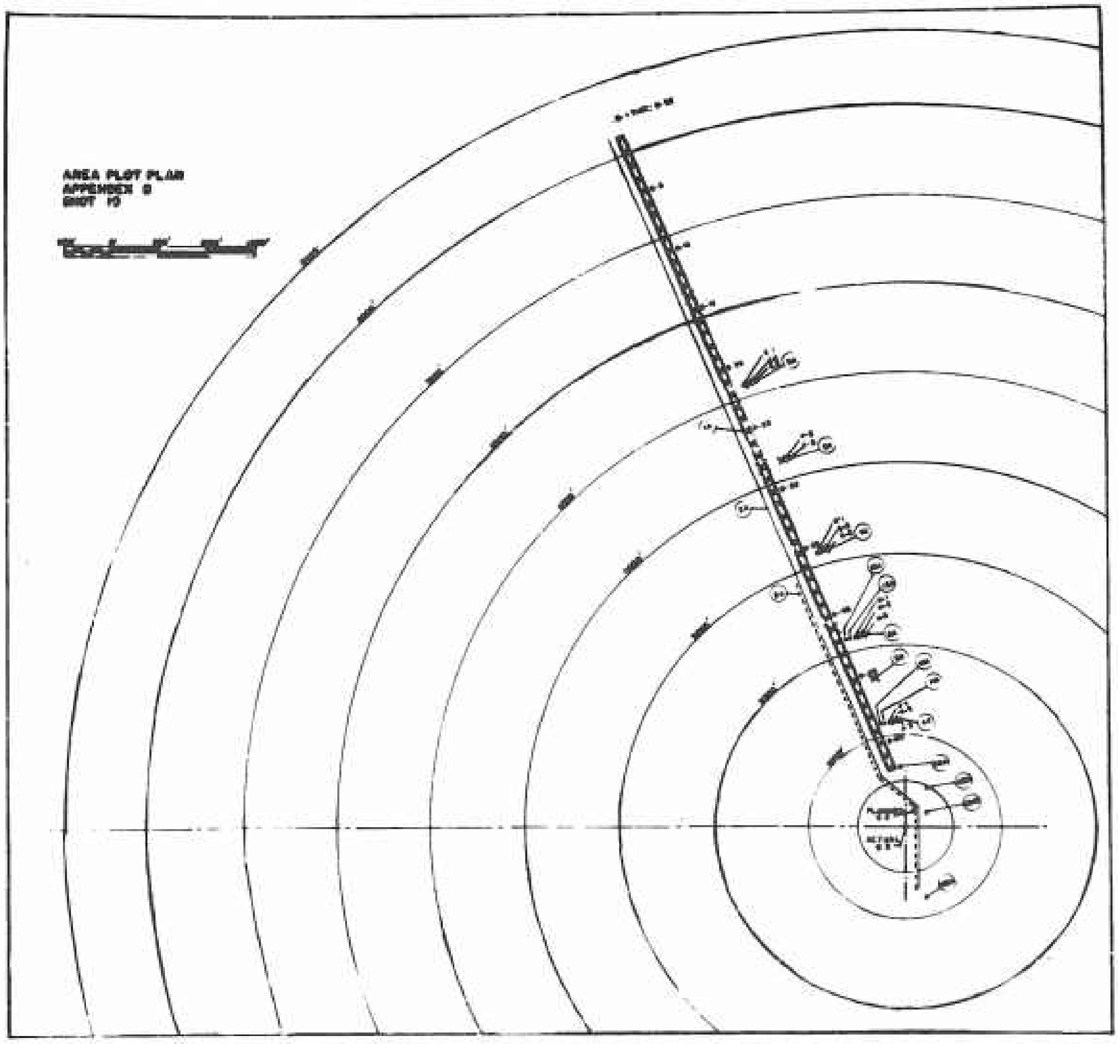


Fig. B.1 Area Plot Plan, Shot 10

TABLE B.1 - Legend, Shot 10

Test Group	*Description	Distance from GZ (ft)	cal	psi
1A	Radial Pole line	600-8350	5.5	1
2A	Surface wire and cable along the radial pole line thru GZ to 800 ft south of GZ	8350N-850S	5.5-90	1-Over 60
3A	Underground wire and cable along the radial pole line thru GZ to 800 ft south of GZ	3140N-800S	40-90	5-Over 60
4A	Three separate poles	1125	Over 60	32
5A	One separate pole	1650	Over 60	11
6A	Three separate poles	2125	Over 60	7
7A	Three separate poles	3125	41	5
8A	Two separate poles	4200	24	4
9A	Three separate poles	5125	16	3
10A	Exposure Board	1125	Over 60	32
11A	Exposure Board	1125	Over 60	32
12A	Exposure Board	2125	Over 60	7
13A	Exposure Board	2125	Over 60	7
14A-95A	Not used			
96A	Manhole (field constructed)	600	Over 65	Over 115
97A-102A	Not used			
103A	One separate pole	500	Over 60	Over 115
104A	One separate pole	300	Over 60	Over 115
105A	One separate pole	800	Over 60	90

* For description of equipment see Appendix G

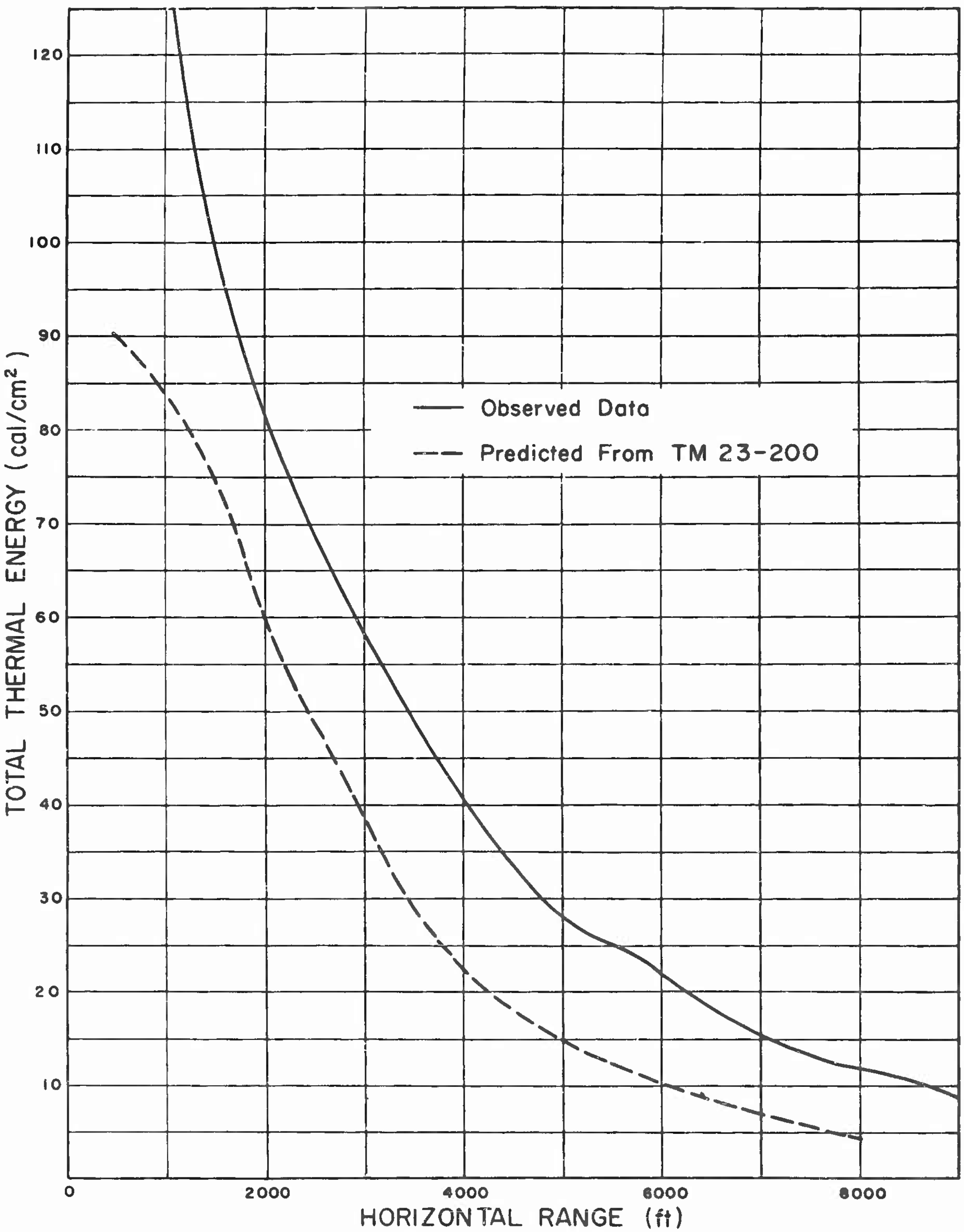


Fig. C.1 Total Thermal Energy vs Horizontal Distance from GZ, Shot 9

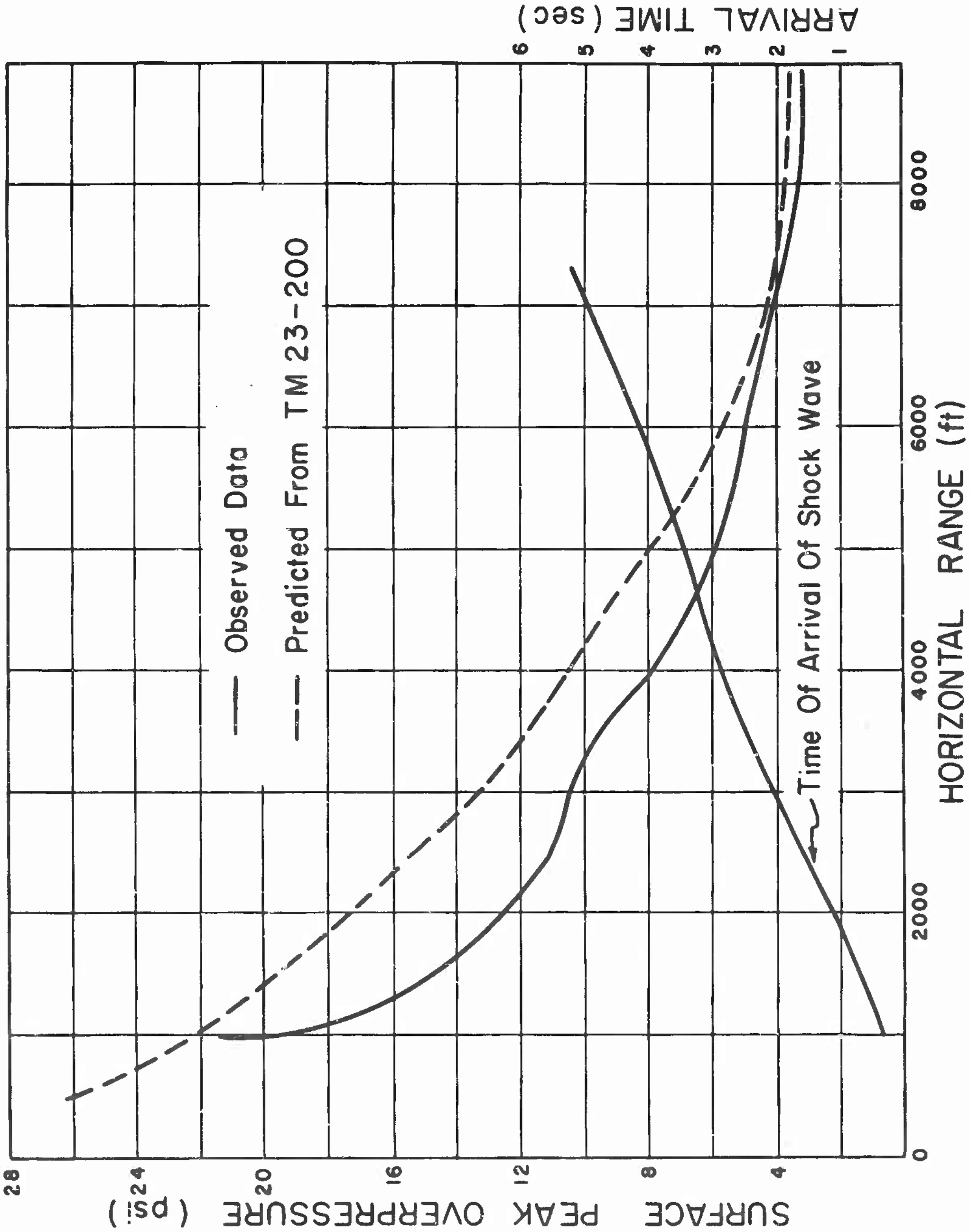


Fig. C.2 Peak Overpressure Along the Surface vs Horizontal Distance from GZ, Shot 9

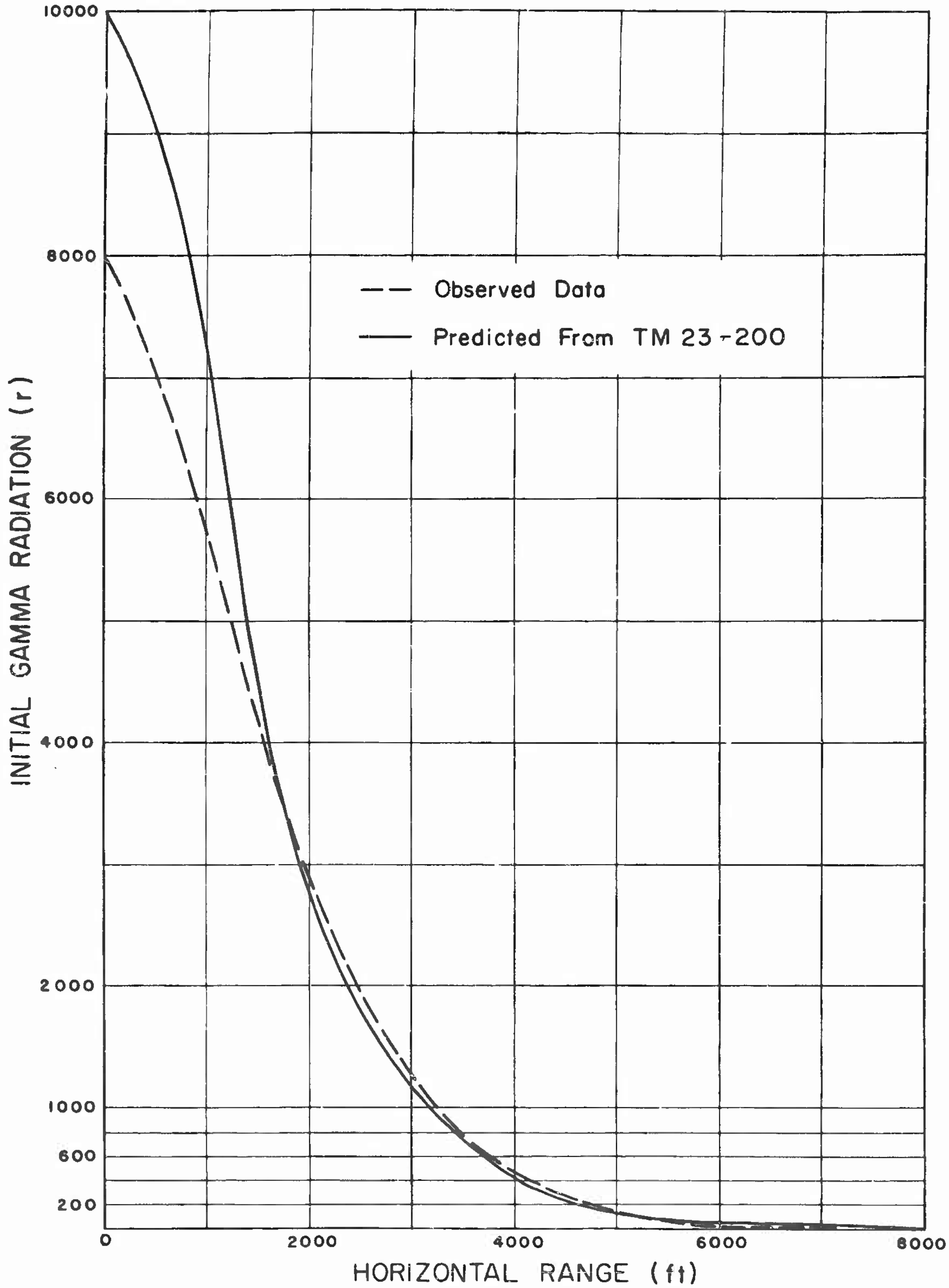


Fig. C.3 Initial Gamma Radiation vs Horizontal Distance from GZ, Shot 9

SECRET — RESTRICTED DATA

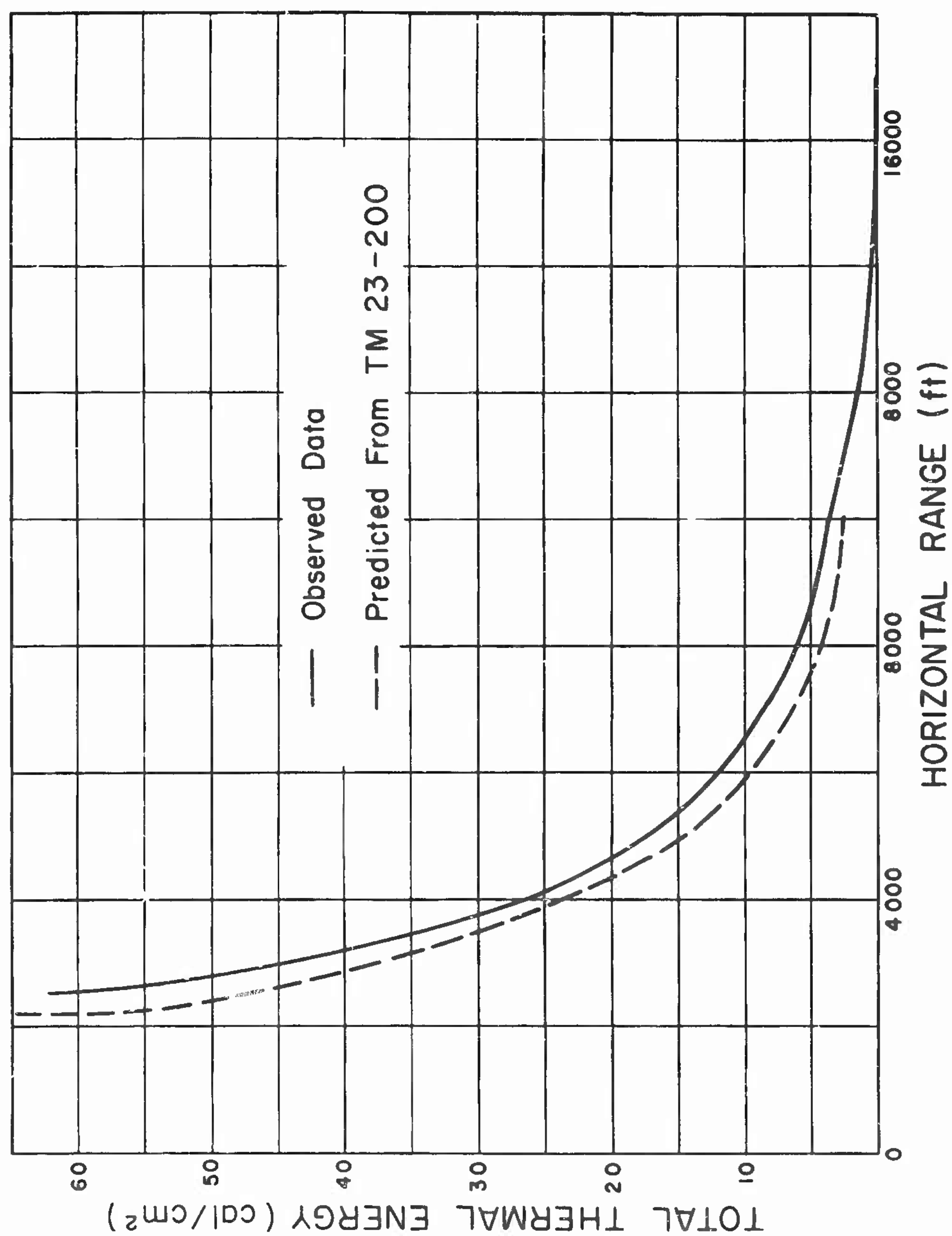


Fig. D.1 Total Thermal Energy vs Horizontal Distance from GZ, Shot 10

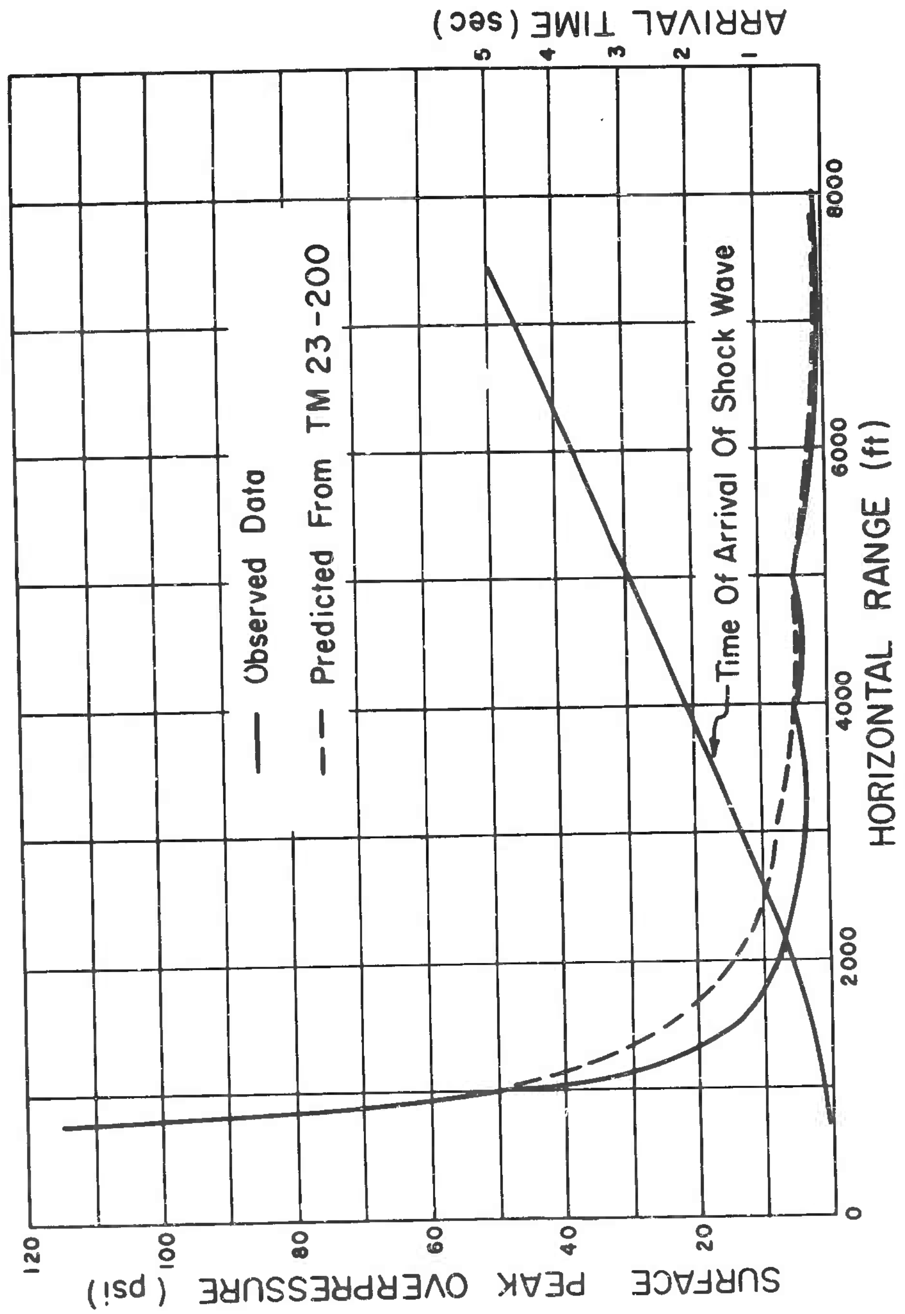


Fig. D.2 Peak Overpressure on the Surface vs Horizontal Distance from GZ, Shot 10

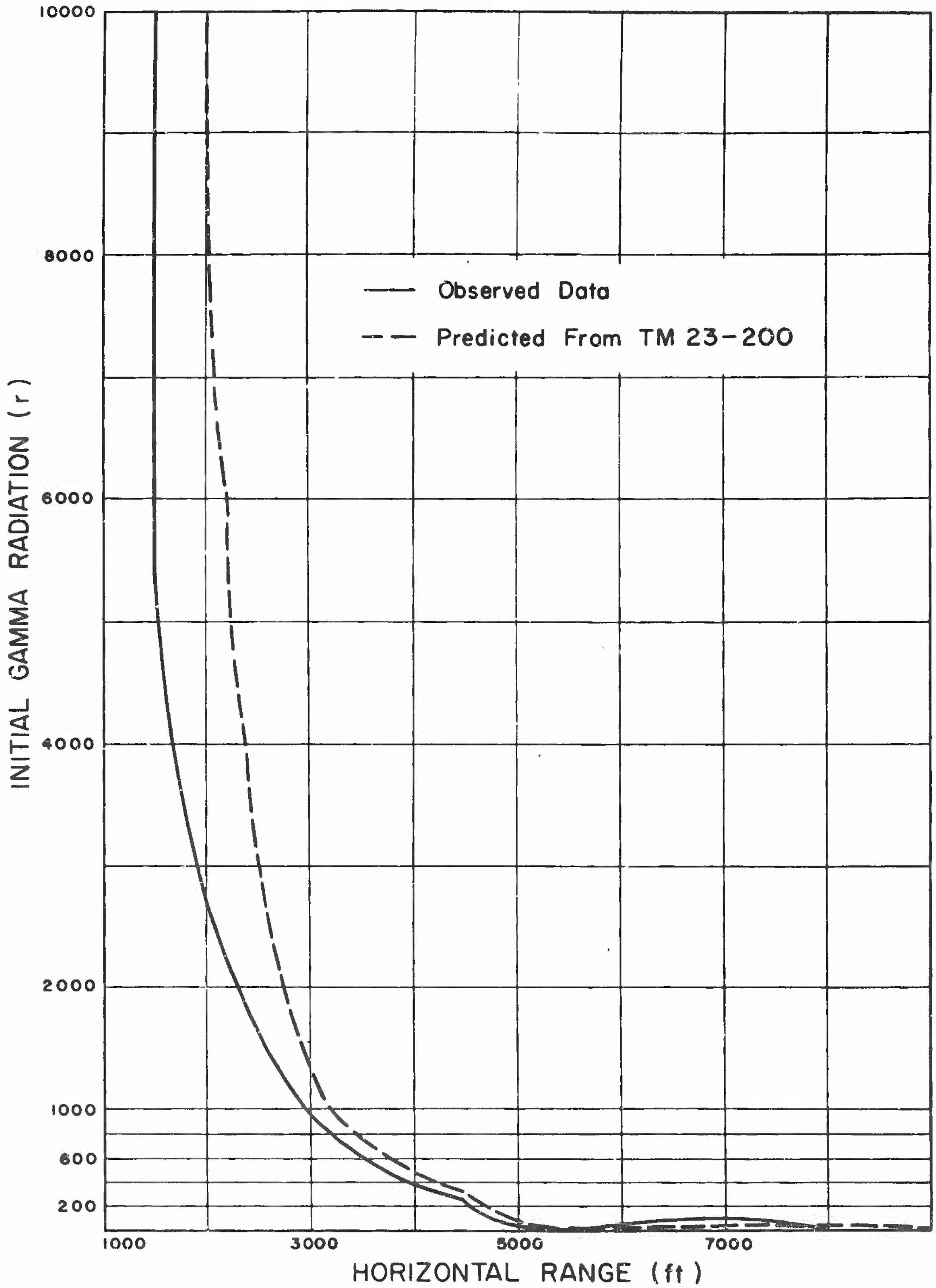


Fig. D.3 Initial Gamma Radiation vs Horizontal Distance from GZ, Shot 10

APPENDIX E

TABLE E.1 - Damage Criteria, Shot 9

S-Severe, M-Moderate
L-Light, N-Negligible

Item	cal	psi	Damage	Remarks
Antennas				
Antenna, whip on AN/GRC-9	-	-	S	
	-	-	M	
	-	-	L	
	94	14	N	Top sections bend.
Antenna, whip on AN/GRC-26	-	-	S	
	-	-	M	
	-	9	L	Some whip antennas will break off.
	94	6	N	
Antenna, whip on AN/PRC-6 in foxhole	90	-	S	Antenna distorted by burning.
	-	-	M	
	-	-	L	
	44	14	N	
Antenna, whip on AN/PRC-10 in foxhole	90	-	S	Antenna distorted by burning.
	-	-	M	
	-	-	L	
	44	14	N	
Antenna Systems				
AN/GRA-4	-	6	S	Collapses, Mast Sections twist and break.
	-	-	M	
	-	-	L	
	28	-	N	
AS-19/TRC-1	-	5	S	Collapses, Mast Sections twist and break.
	-	-	M	
	-	-	L	
	32	-	N	
Antenna Masts and Supports				
AB-26/CR	-	5	S	Collapses, Mast Sections twist and break.
	-	-	M	
	-	-	L	
	40	-	N	

TABLE E.1 - Damage Criteria, Shot 9 (Continued)

Item	cal	psi	Damage	Remarks
AB-155/U	-	5	S	Collapses, Mast Sections twist and break.
	-	-	M	
	-	-	L	
	30	-	N	
AB-224/U	-	6	S	Mast buckles, base and guys loosen.
	-	-	M	
	-	-	L	
	32	5	N	
Lighweight, 30 ft Fiberglass	-	5	S	Collapses, Mast Sections break.
	-	-	M	
	-	-	L	
	29	-	N	
Lightweight, 30 ft Magnesium	-	6	S	Collapses, Mast Sections reusable.
	-	5	M	Remains standing. Guy hardware fails.
	-	-	L	
	29	-	N	
Antenna Masts and Supports Accessories				
Stakes and Anchors	-	-	S	
	-	-	M	
	-	-	L	
	40	15	N	
Guy, Dacron	-	-	S	
	-	-	M	
	40	-	L	Slight Fusing
	-	15	N	
Guy, Nylon	-	-	S	
	-	-	M	
	40	-	L	Slight Fusing
	-	15	N	
Guy, Steel	-	-	S	
	-	-	M	
	40	-	L	Slight Fusing
	-	15	N	
Guy, Steel, Nylon Covered	-	-	S	
	-	-	M	
	40	-	L	Slight Fusing
	-	15	N	

TABLE E.1 - Damage Criteria, Shot 9 (Continued)

Item	cal	psi	Damage	Remarks
Cable				
Alpeth				
on exposure board				
51 pair and 300 pair	-	-	S	
	88	-	M	Slight char, insulation cracks.
	30	-	L	Slight char.
	23	13	N	
Coaxial, Neoprene on exposure board	-	-	S	
	88	-	M	Slight char, insulation cracked.
	30	-	L	Slight char.
	23	13	N	
Lead Covered 5 pair cable on exposure board	88	-	S	Portions of lead sheath melt exposing insulation.
	62	-	M	Slight vaporizing of lead sheath.
	43	-	L	Very light vaporizing of lead sheath.
	30	13	N	
Lead Covered 26 pair cable installed on radial pole line	-	-	S	
	-	-	M	
	113	17	L	Lead sheath may rupture.
	-	-	N	
Lead Covered 26 pair cable installed on transverse pole line	-	7	S	Cable will break in numerous places due to poles breaking.
	-	-	M	
	-	-	L	
	50	6	N	
Lead Covered 26 pair cable installed buried.	-	-	S	
	-	-	M	
	-	-	L	
	over 120	over 21	N	
Rubber Covered, 5 pair CX-162/G cable installed on radial pole line	-	-	S	
	-	-	M	
	-	-	L	
	113	17	N	
Rubber Covered, 5 pair CX-162/G cable installed on transverse pole line	-	7	S	Cable will break in numerous places due to poles breaking.
	-	-	M	
	-	-	L	
	50	6	N	

TABLE E.1 - Damage Criteria, Shot 9 (Continued)

Item	cal	psi	Damage	Remarks
Rubber Covered 5 pair CX-162/G cable installed on exposure board	-	-	S	
	88	-	M	Slight char, insulation cracks.
	30	-	L	Slight char.
	23	13	N	
Rubber Covered 5 pair CX-162/G cable installed on surface lay along radial pole line	-	-	S	
	-	-	M	
	35	-	L	Slight blackening and roughening of surface. Plastic dust caps will burn.
	-	over 21	N	
Rubber Covered 5 pair CX-162/G cable installed along transverse pole line	-	-	S	
	-	-	M	
	-	-	L	
	50	10	N	
Rubber Covered 5 pair CX-162/G cable installed buried along radial pole line	-	-	S	
	-	-	M	
	-	-	L	
	over 120	over 21	N	
Rubber Covered 5 pair CX-162/G in Sig Sup point on the surface on DR-4 w/o wrapping	55	-	S	Some will burn completely, others will burn through several layers of wire.
	-	-	M	
	-	10	L	Reels and boxes blown about.
	24	5	N	
Rubber Covered 5 pair CX-162/G in Sig Sup point on the surface on DR-4 w/wrapping	-	-	S	
	-	-	M	
	24	-	L	Paper wrapping will scorch, little damage to wire under wrapping.
	-	5	N	
Rubber covered 5 pair CX-162/G in Sig Sup point in open pit on DR-4 w/o wrapping	-	-	S	
	-	-	M	
	-	-	L	
	50	10	N	Items will scatter in pit and be covered with dirt but not be damaged.
Rubber Covered 5 pair CX-162/G in Sig Sup point in open pit on DR-4 w/wrapping	-	-	S	
	-	-	M	
	-	-	L	
	55	10	N	Reels will move about and be covered with dirt, no damage.

TABLE E.1 - Damage Criteria, Shot 9 (Continued)

Item	cal	psi	Damage	Remarks
Spiral Four CX-1065/G installed on radial pole line	-	-	S	
	-	-	M	
	113	-	L	Rubber jacket softens causing slippage in suspension bracket. Jacket blackens and roughens.
	-	17	N	
Spiral Four CX-1065/G installed on transverse pole line	-	7	S	Cable will break in numerous places due to poles breaking.
	-	6	M	
	-	-	L	
	35	-	N	
Spiral Four CX-1065/G installed on exposure board	-	-	S	
	-	-	M	
	23	-	L	Slight char on outer jacket.
	17	13	N	
Spiral Four CX-1065/G installed on surface transverse pole line	-	-	S	
	-	-	M	
	-	-	L	
	50	10	N	
Spiral Four CX-1065/G installed on surface along radial pole line	-	-	S	
	-	-	M	
	32	-	L	Slight blackening and roughening of rubber jacket.
	30	over 21	N	
Spiral Four CX-1065/G installed buried along radial pole line	-	-	S	
	-	-	M	
	-	-	L	
	over 120	over 21	N	
Spiral Four CX-1065/G installed in Sig Sup point on surface on DR-8 w/o wrapping	55	-	S	Some will burn completely, others will burn through several layers of wire.
	-	-	M	
	-	10	L	Reels and boxes blown about.
	24	5	N	
Spiral Four CX-1065/G installed in Sig Sup point on surface on DR-8 w/wrapping	-	-	S	
	-	-	M	
	24	-	L	Paper wrapping will scorch, little damage to wire under wrapping.
	-	5	N	

TABLE E.1 - Damage Criteria, Shot 9 (Continued)

Item	cal	psi	Damage	Remarks
Poles				
Southern Pine Creosoted	-	-	S	
Class 3, 45 ft, set 6 ft	-	-	M	
separate poles unguyed	-	-	L	
	85	13	N	Slight scorching, poles will loosen some.
Southern Pine Creosoted	-	-	S	
Class 7, 30 ft, set $5\frac{1}{2}$ ft	-	-	M	
in pole line systems	-	-	L	
radial	113	17	N	Surface of poles will char lightly. Minor checks may develop.
Southern Pine Creosoted Class 7, 30 ft, set $5\frac{1}{2}$ ft	-	7	S	All poles can be expected to be broken.
in pole line systems transverse	-	6	M	Most of the poles will break.
	-	-	L	
	35	-	N	
Southern Pine Creosoted	-	-	S	
Class 7, 30 ft, set $5\frac{1}{2}$ ft	-	-	M	
in pole line systems	-	-	L	
separate poles unguyed	over 120	over 21	N	Slight scorching, poles will loosen some.
Southern Pine Creosoted	-	-	S	
Class 7, 30 ft, set $5\frac{1}{2}$ ft	-	-	M	
in pole line systems	-	-	L	
guyed 4 way storm guy	over 120	over 21	N	Slight scorching, guys will slacken, poles will loosen some.
Radio Set, AN/GRC-9 in a	-	-	S	
jeep	-	-	M	
	94	11	L	Chassis will scorch slightly, calibration charts will burn, some damage to external connections, antennas will bend.
	58	-	N	
Radio Set, AN/GRC-26 on a $2\frac{1}{2}$ ton truck	58	11	S	Severe burning to complete destruction. Blast will cave top and sides in.
	-	-	M	
	-	-	L	
	-	-	N	

TABLE E.1 - Damage Criteria, Shot 9 (Continued)

Item	cal	psi	Damage	Remarks
Radio Set, AN/GRC-26 In a S-56 shelter revetted with front end facing the blast	-	6	S	Blast will blow front in and debris will cause secondary damage.
	-	-	M	
	-	-	L	
	25	-	N	Paint will burn and scorch exposed parts.
Radio Set, AN/PRC-6 in a foxhole	90	-	S	Will burn completely. May burn at much lower thermal flux depending upon orientation, shielding, depth of foxhole and materials which could cause secondary fires.
	-	-	M	
	-	-	L	
	-	14	N	Several inches of dirt may be blown in foxhole, no damage.
Radio Set, AN/PRC-10 in a foxhole	90	-	S	Will burn completely. May burn at much lower thermal flux depending upon orientation, shielding, depth of foxhole and materials which could cause secondary fires.
	-	-	M	
	-	-	L	
	-	14	N	Several inches of dirt may be blown into foxhole.
Radio Set, AN/TRC-1 in a container in a Sig Sup point on the surface	55	-	S	Packing boxes may burn and cause secondary fires to contents.
	-	-	M	
	-	10	L	Containers will be blown about.
	-	5	N	
Headset, H-16/U on exposure boards	-	-	S	
	-	-	M	
	88	-	L	Slight char on exposed rubber parts.
	-	13	N	
Headset, H-33/PT	-	-	S	
	-	-	M	
	88	13	L	Slight char on exposed rubber parts. Membranes and transmitter caps may rupture.
	-	-	N	

TABLE E.1 - Damage Criteria, Shot 9 (Continued)

Item	cal	psi	Damage	Remarks
Meter, part of BC-610 transmitter in S-56 shelter, revetted standard	-	14	S	
	-	-	M	
	-	-	L	
	91	6	N	Internal parts may break on some meters.
Ruggedized Meter	-	-	S	
	-	-	M	
	-	-	L	
	91	14	N	
Microphone on exposure board M-29/U	-	-	S	
	-	-	M	
	89	-	L	Slight char on exposed rubber parts.
	-	13	N	
Reflector Parabolic radio relay, 6 ft dia. on Antenna AB-26/CR	-	8	S	Reflector will be distorted by blast and by secondary effects in falling to ground.
	-	-	M	
	-	5	L	Reflector will be slightly distorted in falling to ground.
	40	-	N	
on 120 ft high tower	-	7	S	Reflectors broken and bent in falling to ground.
	-	-	M	
	-	-	L	
	51	-	N	
on 200 ft high tower	-	-	S	
	-	5	M	Reflector may become deformed and require reorientation.
	-	-	L	
	36	-	N	
Relay, Cable transfer in pole line systems				
Radial pole line	-	-	S	
	-	-	M	
	-	-	L	
	113	17	N	
Transverse pole line	-	-	S	
	-	-	M	
	-	-	L	
	50	10	N	
in manhole	-	-	S	
	-	-	M	
	-	-	L	
	113	17	N	

TABLE E.1 - Damage Criteria, Shot 9 (Continued)

Item	cal	psi	Damage	Remarks
Shelters, S-56 type on a $2\frac{1}{2}$ ton truck	-	14	S	Blown in, frame twisted beyond repair.
	-	-	M	
	94	-	L	Paint scorched.
	-	-	N	
on the surface	-	5	S	Blown in and torn apart.
	-	-	M	
	-	-	L	
	57	-	N	
revetted, part of AN/GRC-26, front end facing GZ	-	6	S	Front blown in and torn apart.
	-	-	M	
	-	-	L	
	25	-	N	
revetted, front end away from GZ	-	12	S	Front blown in and torn apart.
	-	-	M	
	-	-	L	
	72	-	N	
Structures See Corps of Engineers and Federal Civil Defense Administration Final Reports.				
Supply Point, Signal, uncovered surface	32	-	S	Some exposed items will burn and may cause secondary fires.
	24	-	M	Exposed items may burn and cause secondary fires.
	-	13	L	Some items will be blown to 120 ft or more.
	-	5	N	
in open pit	-	-	S	
	-	-	M	
	-	-	L	
	55	10	N	Items will be scattered about in pit and be covered with dirt.
Supply Power Generator Hand, GN-58A in Corps of Engineers Installation U. G.	-	-	S	
	-	-	M	
	-	-	L	
	over 125	over 21	N	Equipment covered with heavy coat of dust, no damage.

TABLE E.1 - Damage Criteria, Shot 9 (Continued)

Item	cal	psi	Damage	Remarks
Pack, Power PE-237	-	-	S	
in jeep	-	-	M	
	-	7	L	Case may be dented and top cover loosened.
	33	-	N	
Unit, Power, PE-75	-	-	S	
in container in a Sig	-	-	M	
Sup point on surface	-	10	L	Packing crate may break and jolting may cause light damage to unit.
	88	9	N	
Unit, Power, PE-95	-	-	S	
in K-52 trailer attached	-	-	M	
to $2\frac{1}{2}$ ton truck on surface	-	14	L	Unit may overturn, should be operable after minor repairs made.
	94	-	N	
in K-52 trailer revetted	-	-	S	
radial to blast	-	-	M	
	-	7	L	Exposed parts may be damaged but should be operable after minor repairs made.
	34	-	N	
in K-52 trailer revetted	-	-	S	
transverse to blast	-	-	M	
	-	9	L	Exposed parts may be damaged but should be operable after minor maintenance repairs.
	46	-	N	
Systems, Public Address Loudspeaker, LS-103/TIQ-2 on exposure board	-	13	S	Horns will blow off, internal damage will occur on all units.
	-	9	M	Some of the horns will be dislodged.
	43	-	L	Paint will blister.
	30	6	N	
Telephones				
EE-8 w/o case	-	3	S	Internal parts damaged.
on exposure board	-	-	M	
	88	-	L	Slight char on rubber insulation and bakelite.
	23	-	N	

TABLE E.1 - Damage Criteria, Shot 9 (Continued)

Item	cal	psi	Damage	Remarks
Telephones				
EE-8 w/canvas case	-	-	S	
on exposure board	-	-	M	
	88	6	L	Slight scorch on canvas case. Slight internal blast damage.
	-	3	N	
Towers				
Sectionalized				
Alluminum, Lighweight				
120 ft high	-	6	S	Towers remain standing, members twist and bend, not safe to use.
	-	-	M	
	51	-	L	Paint scorches and burns.
	-	-	N	
200 ft high	-	-	S	
	-	5	M	Tower remains standing, vertical members may fail.
	-	-	L	Paint slightly charred.
	19	-	N	
Hardware, tower				
Anchor	-	-	S	
	-	-	M	
	-	-	L	
	51	10	N	
Clevis (shackle)	-	-	S	
	-	-	M	
	-	-	L	
	51	10	N	
Guy, steel Nylon covered	-	-	S	
	-	-	M	
	-	-	L	
	51	10	N	Nylon slightly fused.
Vehicles				
See Ordnance Corps project final report.				
Wire				
Box, junction, JB-11	-	-	S	
	-	-	M	
	-	-	L	
	113	17	N	

TABLE E.1 - Damage Criteria, Shot 9 (Continued)

Item	cal	psi	Damage	Remarks
Wire				
Hardware, pole line				
Anchor	-	-	S	
	-	-	M	
	-	-	L	
	113	17	N	
Bracket, drop, standard transposition	-	-	S	
	-	-	M	
	-	-	L	
	113	17	N	
Crossarms, 10 pin, wood on pole lines				
Radial	-	-	S	
	-	-	M	
	-	-	L	
	113	17	N	
Transverse	-	7	S	Some will break due to blast others will break due to poles breaking.
	-	6	M	Some will break due to blast others will break due to poles breaking.
	-	-	L	
	50	-	N	
Guy steel, 6m	-	-	S	
	-	-	M	
	-	-	L	
	113	17	N	
Strip, terminal TM-184 on poles				
unshielded	-	-	S	
	-	-	M	
	-	-	L	
	113	17	N	
shielded	-	-	S	
	-	-	M	
	-	-	L	
	113	17	N	
In Corps of Engineers Installations, U. G.	-	-	S	
	-	-	M	
	-	-	L	
	over 125	over 21	N	These values are at the surface, internal values not known.

TABLE E.1 - Damage Criteria, Shot 9 (Continued)

Item	cal	psi	Damage	Remarks
Insulator, glass on cross-arms in pole line system	-	-	S	
	113	17	M	Some insulators will break.
	-	-	L	A few insulators will break.
	-	-	N	
On exposure board	-	-	S	
	-	-	M	
	-	-	L	
	88	13	N	
Insulator, rubber on exposure board	-	-	S	
	-	-	M	
	-	-	L	
	88	13	N	Slight loss of glaze, will gather powder bloom with time which will not destroy insulation properties.
Pin, Insulator on crossarm in pole line system				
Radial	-	-	S	
	-	-	M	
	-	-	L	
	113	17	N	
Transverse	-	-	S	
	-	-	M	
	-	6	L	Pins will be blown from crossarms but not damaged of themselves.
	50	-	N	
Wire, Field WD-1/TT in pole line system				
Aerial				
Radial pole line	63	11	S	Wires will fuse at field ties exposing conductors, wire will break and be blown from poles.
	52	10	M	Moderate fusing, some broken wires blown from poles.
	31	-	L	Nylon covering burns or chars.
	24	9	N	

TABLE E.1 - Damage Criteria, Shot 9 (Continued)

Item	cal	psi	Damage	Remarks
Transverse pole line	35	6	S	Field wire will burn. Blast and falling poles will cause it to break.
	-	-	M	
	-	-	L	
	50	-	N	
On exposure boards	43	-	S	Insulation melts exposing conductors
	-	-	M	
	10	-	L	Nylon burns off exposing polyethylene insulation.
	-	13	N	
Surface lay radial	35	-	S	Insulation burn off wires exposed or fused.
	-	-	M	
	22	-	L	Insulation chars, wires will be damaged if tied to stakes.
	21	over 21	N	
Surface lay along transverse pole lines	35	7	S	Wire will burn and be blown about.
	25	6	M	Some wire will burn and be blown about.
	-	-	L	
	-	-	N	
Underground	-	-	S	
	-	-	M	
	-	-	L	
	over 120	over 21	N	
In Sig Sup point on surface, on DR-4 In dispenser MX-306/G	-	-	S	
	-	-	M	
	88	13	L	Some dispensers will scorch on exposed surfaces; some dispensers will be blown 120 ft or more.
	24	5	N	
In Sig Sup Point in open pit in dispenser MX-306/G	-	-	S	
	-	-	M	
	-	-	L	
	55	10	N	Dispensers will be blown about in pit and be covered with dirt, no damage.

TABLE E.1 - Damage Criteria, Shot 9 (Continued)

Item	cal	psi	Damage	Remarks
WD-14/TT, on exposure boards	43	-	S	Insulation melts, conductors fuse.
	9	-	M	Nylon burns, polyethylene cracks exposing conductors.
	-	-	L	
	-	-	N	
WD-110-B				
In Sig Sup Point on surface, on DR-8				
w/o wrapping	32	-	S	Some reels and wire will burn completely. Others will scorch.
	24	-	M	Some reels will burn through 2 inches or more of wire on reels.
	-	-	L	
	-	5	N	Some reels will be blown about, no damage.
w/wrapping	-	-	S	
	-	-	M	
	-	-	L	
	24	5	N	Wrapping slightly scorched; reels will scatter, no damage.
In Sig Sup Point in open pit on DR-8				
w/o wrapping	-	-	S	
	-	-	M	
	-	-	L	
	55	10	N	Reels will scatter in pit and be covered with dirt, no damage.
w/wrapping	-	-	S	
	-	-	M	
	-	-	L	
	55	10	N	Reels will scatter in pit and be covered with dirt, no damage.
Wire, cable, lashing, stainless steel, .045 inch dia. in pole line cable systems				
Aerial				
Radial	-	-	S	
	-	-	M	
	73	12	L	Cable lashing wire will break, infrequently.
	69	11	N	

TABLE E.1 - Damage Criteria, Shot 9 (Continued)

Item	cal	psi	Damage	Remarks
Transverse	-	-	S	
	-	-	M	
	-	-	L	
	50	10	N	
Wire, open, 104 CS, on cross-arms in pole line systems				
Radial	-	-	S	
	-	-	M	
	-	-	L	
	113	17	N	
Transverse	-	-	S	
	-	-	M	
	-	-	L	
	50	10	N	
Wire, tie, in pole line systems				
Radial	-	-	S	
	-	-	M	
	-	-	L	
	113	17	N	
Transverse	-	-	S	
	-	-	M	
	-	-	L	
	50	10	N	

TABLE F.1 – Damage Criteria, Shot 10

S – Severe, M – Moderate
L – Light, N – Negligible

Item	cal	psi	Damage	Remarks
Cable				
Alpeth, 51 pair and 300 pair on exposure board	over 60	7	S	Cable jacket severely burned.
	–	–	M	
	–	–	L	
	–	–	N	
Coaxial, neoprene on exposure board	over 60	over 7	S	Cable jacket severely burned.
	–	–	M	
	–	–	L	
	–	–	N	
Lead covered, 5 pair on exposure board	over 60	over 7	S	Cable sheath melted.
	–	–	M	
	–	–	L	
	–	–	N	
Lead covered, 26 pair aerial	over 90	over 60	S	Cable melts, breaks and snarled up on ground. Melting starts where thermal flux of over 90 cal/cm^2 exists, decreasing out to 43 cal. Blast damage severe starting at point where over 60 psi exists, ending abruptly at 5 psi. Damage ends abruptly from severe to none.
	–	–	M	
	–	–	L	
	43	5	N	Slight scorching and roughening, darkening under suspension clamps, no damage.
Headset, H-16/U on exposure board	over 60	over 7	S	Severe burning, external and internal damage.
	–	–	M	
	–	–	L	
	–	–	N	

TABLE F.1 - Damage Criteria, Shot 10 (Continued)

Item	cal	psi	Damage	Remarks
Microphone, M-29 on exposure board	over 60	over 7	S	Severe burning, external and internal damage.
	-	-	M	
	-	-	L	
	-	-	N	
Systems, Public Address Loudspeakers, LS-103/TIQ-2	over 60	over 7	S	Severe burning, external and internal damage
	-	-	M	
	-	-	L	
	-	-	N	
Underground				
at terminal closest to GZ	over 60	over 90	S	Wire protruding from ground evaporates.
	-	-	M	
	-	-	L	
	over 60	over 90	N	
terminal farthest from GZ	-	-	S	
	-	-	M	
	-	-	L	
	45	5	N	
underground wire proper	-	-	S	
	-	-	M	
	-	-	L	
	over 60	over 90	N	
terminal farthest from GZ	-	-	S	
	-	-	M	
	-	-	L	
	47	5	N	
Lead underground terminal closest to GZ	over 60	over 90	S	Riser cable lead sheath melts and cable may break.
	-	-	M	
	-	-	L	
	-	-	N	
Buried cable proper	-	-	S	
	-	-	M	
	-	-	L	
	over 60	over 90	N	
Terminal farthest away from GZ	-	-	S	
	-	-	M	
	-	-	L	
	49	9	N	

TABLE F.1 - Damage Criteria, Shot 10 (Continued)

Item	cal	psi	Damage	Remarks
Rubber covered Spiral Four CX-162/G Aerial	over 47	over 5	S	Melted, broken and scorched up on ground starting at over 65 cal, decreasing to no damage at 47 cal.
	-	-	M	
	-	-	L	
	47	5	N	
Rubber covered Spiral Four CX-162/G on exposure board	over 60	7	S	Rubber jacket burns.
	-	-	M	
	-	-	L	
	-	-	N	
Rubber covered Spiral Four CX-162/G surface lay	over 60	over 90	S	Intermittently melted, fused, broken and snarled up, starting at over 60 cal over 90 psi; damage ends abruptly at 43 cal and 5 psi.
	-	-	M	
	-	-	L	
	47	5	N	
Underground terminal closest to GZ	over 60	over 90	S	Cable protruding from under ground evaporates.
	-	-	M	
	-	-	L	
	-	-	N	
Cable proper	-	-	S	
	-	-	M	
	-	-	L	
	over 60	over 90	N	
Terminal farthest away from GZ	-	-	S	
	-	-	M	
	-	-	L	
	49	9	N	
Spiral Four, CX-1065G Aerial	over 47	over 5	S	Melted, broken and snarled up on ground. Damage ends abruptly at 47 cal and 5 psi.
	-	-	M	
	-	-	L	
	47	5	N	Slight scorching and roughening of cable.

TABLE F.1 - Damage Criteria, Shot 10 (Continued)

Item	cal	psi	Damage	Remarks
Spiral Four, CX-1065G on exposure board	over 60	over 7	S	Jacket burns.
	-	-	M	
	-	-	L	
	-	-	N	
Spiral Four, CX-1065G Surface lay	over 60	over 90	S	Intermittently melted, fused, broken, and snarled up starting at over 90 cal, over 60 psi. Damage ends abruptly at 43 cal, 5 psi.
	-	-	M	
	-	-	L	
	47	5	N	
Spiral Four, CX-1065G underground terminal closest to GZ	over 60	over 90	S	Cable protruding from GZ evaporated.
	-	-	M	
	-	-	L	
	-	-	N	
Spiral Four, CX-1065G underground cable proper	-	-	S	
	-	-	M	
	-	-	L	
	over 60	over 90	N	
Spiral Four, CX-1065G terminal farthest away from GZ	-	-	S	
	-	-	M	
	-	-	L	
	47	5	N	
Spiral Four, CX-1065G manhole, field constructed	over 65	over 115	S	Manhole will cave in; no damage to internal cables.
	-	-	M	
	-	-	L	
	-	-	N	
Messenger, W-115 on poles Radial	over 65	over 115	S	Snarled up with wire and cable on ground. Damage ends abruptly at 47 cal and 5 psi.
	-	-	M	
	-	-	L	
	47	5	N	
Radio Handset T-33 on exposure board	over 60	7	S	Severe burning; external and internal blast damage.
	-	-	M	
	-	-	L	
	-	-	N	

TABLE F.1 - Damage Criteria, Shot 10 (Continued)

Item	cal	psi	Damage	Remarks
Wire, WD-1/TT Radial Aerial	over 65	over 115	S	Evaporates, melts, fuses, breaks, and snarled upon ground.
	37	5	M	Blistered at field ties, sags up to 9 ft from ground.
	27	-	L	Wire scorches in span and at field ties, abnormal sag.
	-	-	N	
Wire, WD-1/TT on exposure board	over 60	7	S	
	-	-	M	
	-	-	L	
	-	-	N	
Wire, WD-1/TT on surface lay	over 60	over 90	S	Evaporates, melts, fuses, and snarls up on ground.
	-	-	M	
	-	5	L	Wire may break in mid span.
	37	-	N	
Vehicles, Ordnance (See Ordnance Corps project final report.)				
Wire Box, Junction JB-11	over 60	over 90	S	Evaporate, melt, and fuse. Damage ends abruptly at 47 cal and 5 psi.
	-	-	M	
	-	-	L	
	47	5	N	
Hardware, pole line Anchor	over 65	over 115	S	In original position but snarled up beyond repair.
	-	-	M	
	-	-	L	
	24	4	N	
Hardware, pole line Bracket (drop standard transposition	-	-	S	
	-	-	M	
	-	-	L	
	47	5	N	
Crossarm, 10 pin, wood	over 65	over 115	S	Disintegrated, splintered and broken. Damage ends abruptly at 47 cal and 5 psi.
	-	-	M	
	-	-	L	
	47	5	N	

TABLE F.1 - Damage Criteria, Shot 10 (Continued)

Item	cal	psi	Damage	Remarks
Pole, separate, southern pine, creosoted Class 7, 30 ft guyed, set $5\frac{1}{2}$ ft	over 60	11	S	Poles disintegrate and disappear or break and scatter about the area from over 60 cal, over 115 psi, to over 60 cal, 11 psi, where damage ends abruptly.
	-	-	M	
	-	-	L	
	41	5	N	Slight char, guys loose, poles loose, no damage.
Telephone EE-8 w/canvas case on exposure board	over 60	7	S	Case burned, severe external and internal blast damage.
	-	-	M	
	-	-	L	
	-	-	N	
TP-6 on exposure board	over 60	7	S	Case burned, severe external and internal damage to components.
	-	-	M	
	-	-	L	
	-	-	N	
Strip, terminal TM-184 on pole, unshielded	over 65	over 115	S	Disintegrate or disappear.
	-	-	M	
	-	-	L	
	47	5	N	
Strip, terminal TM-184 on pole, shielded	over 65	over 115	S	Disintegrate or disappear.
	-	-	M	
	-	-	L	
	47	5	N	
Wire, cable, lashing stainless steel .045 in. dia. Aerial	-	-	S	
	-	-	M	
	-	-	L	
	47	5	N	
Wire, open, 104 CS on crossarms in pole line system Radial	over 65	over 115	S	Broken and snarled up on ground. Damage ends abruptly where 47 cal and 6 psi exist.
	-	-	M	Severe damage ends abruptly at these figures from 43 cal, 5 psi to 5 cal, 1 psi, the wire darkens, abnormally sags and transposition clearances

TABLE F.1 - Damage Criteria, Shot 10 (Continued)

Item	cal	psi	Damage	Remarks
				are reduced to point where high winds will cause wire to short circuit.
	47	5	L	
	5	1	N	
Wire, tie, on insulators in pole line system	-	-	S	
	-	-	M	
	-	-	L	
	47	5	N	

APPENDIX G

DEFINITION OF EQUIPMENT USED IN PROJECT 3.20

A. Mast AB-224/U is a 25 foot telescoping steel antenna support. It consists of nine sections which telescope to a packaged height of 56 inches. Erection is accomplished by means of a manual crank through gears, pulleys and cables. The mast is guyed at the top, and at the bottom of the fourth section from the top, with 3/16" diameter nylon guys set with an angle of 120° between guys.

B. Antenna Support AB-26C/CR is a 70 foot high, guyed, latticed, triangular steel mast for supporting various type rhombic antennas. It is made up of seven identical, triangular sections measuring 6-1/2 in. across each face and 10 ft long, joined together and attached to a double acting hinged magnesium base which permits the support to be raised or lowered completely assembled. A 30 ft boom, made up of three sections identical to those which make up the mast, is also attached to the hinged base and used when the mast is being raised or lowered. The guys are fabricated of 5/32 in. diameter, nylon covered, flexible steel wire rope with a breaking strength of 2800 lb. A back-up guy is provided which is similarly fabricated of 3/16 in. steel wire rope, nylon covered, with a breaking strength of 4200 lb. All guys are provided with glazed ceramic strain insulators.

C. Mast AB-155/U is a 40 ft high, guyed, tubular steel, sectional mast for supporting various doublet antennas. It is made up of eight 5 ft long x 1-5/8 in. diameter sections. The mast is guyed at the top and two lower levels with 3/16 in. diameter nylon or dacron guys. The mast is normally supplied with nylon guys. In order to determine the effects on a different guy material, dacron was substituted for nylon in Test Group 54.

D. Antenna System AS-19/TRC-1 consists of Antenna Support AB-33/TRC-1 and Antenna AS-20/TRC-1. The mast consists of ten 2 in. diameter x 5 ft long tubular steel mast sections giving an assembled height of 50 ft for the mast. The antenna utilizes a 2-1/2 ft high insulated mast section making the overall height of the system 52-1/2 ft. The antenna is a 6 element array mounted at the top of the insulated mast section. A coaxial cable connects to the array junction box and extends down to the base of the mast. The mast is guyed at three levels with four 3/16 in. diameter nylon guys.

E. Scaffold Tower, Type AB-216/U is an aluminum sectionalized guyed structure consisting of interchangeable sections except for the bottom or base section. Each section measures 4 ft wide x 6 ft long x 6 ft high and is complete with an integral ladder and platform. The basic tower height is 78 ft. By the use of auxiliary kits the height may be increased to any desired 6 ft increment up

to 204 ft. The major structural members are constructed from 2 in. outside diameter 61ST6 aluminum tubing. The guys used are constructed of 7/32 in. diameter, nylon covered, flexible steel wire rope with a breaking strength of 5500 lb. The outside diameter of the nylon jacket is 5/16 in.

F. Antenna Group AN/GRA-4 is a portable, half-wave antenna assembly designed for radio transmission and reception consisting of one Antenna AS-244/GRA-4 and two AN Masts AB-86/GRA-4. The mast assembly consists of sixteen 1-3/8 in. diameter x 36 in. long aluminum mast sections and in addition is supplied with a fiberglass base insulator which assembles between the first and second section from the bottom. The assembled mast measures 40 ft high and is guyed at the top and at two lower levels. The mast is normally supplied with 3/16 in. diameter nylon guys. In order to determine the effects on a different guy material, 3/16 in. diameter dacron was substituted for nylon in Test Group 47. The lighweight masts tested were experimental designs of various tubular shapes using fiberglass sections or magnesium sections. The masts were erected to a height of approximately 30 ft, guyed at the top and at two lower levels. The guy material used was either 3/16 in. diameter nylon or dacron. The antenna supported at the top of each installation consisted of a six element circular array, each element of which was made up of 1 Mast Section AB-23 and 1 Mast Section AB-24 making the assembled element length approximately 48 in.

G. Radio Set AN/GRC-9 is a combined two-way radio telephone and radio telegraph unit designed to provide communication between moving or stationary vehicles. It may also be used as a portable field set.

H. Vibrator Power Unit PE-237. The vibrator power unit is a vehicular operational component capable of supplying all voltages required for Radio Set AN/GRC-9. It consists of two independent power supply systems (a heavy duty unit for supplying power to the receiver and transmitter for normal two-way communication, and a small unit for supplying only receiver voltage during long periods of listening).

I. Generator GN-58. A hand-operated generator is also supplied with Radio Set AN/GRC-9 to provide filament and plate voltage to the receiver and transmitter. The generator is supplied complete with crank handles and legs for mounting and operating the equipment.

J. Power Units PE-75 are self-contained, compact, portable, gasoline-engine-driven generating sets of the manual-starting type. They are designed to deliver 2,500 watts at 120 volts, 60-cycle, alternating current.

K. Radio Sets AN/PRC-8 and 10 are portable, f-m (frequency-modulated) radio sets intended to provide man-pack communications for armored, artillery, and infantry units, respectively.

The radio sets are battery-powered; they can be operated in airplane and vehicle installations, in semipermanent ground installations, or while being carried by the operator. Provision is also made for homing use, remote operation, and unattended relay operation, using two sets.

L. Radio Set AN/PRC-6 is a miniaturized, low-power, battery-operated radio receiver and transmitter designed for f-m (frequency-modulated)

communication over short distances. Highly portable, it is intended primarily as a handy-talkie for foot-combat troops.

The set is self-contained, all operating components necessary for reception and transmission are contained in a two-piece cast-magnesium case. The set may be held in either hand when operating. The microphone and the earphone are located inside the case in such a manner that the set resembles a hand-telephone. An adjustable strap is attached to the case of Radio Set AN/PRC-6 for carrying and also to provide additional support when used in the operating position. The total weight of the equipment including the battery is approximately 7 pounds.

M. Radio Set AN/GRC-26A consists of a transportable assembly of equipment which provides facilities for the transmission and reception of RTT (radio teletypewriter) signals by means of FS (frequency-shift) modulation over a range of 2 to 18 mc. In addition, c-w (continuous-wave) telegraphy and voice facilities are provided. The a-m (amplitude-modulated) voice signals can be sent alone or together with the FS modulated RTT signals. The radio set can be operated when in motion or when at halt using two types of operation, full-duplex or one-way reversible. The teletypewriter equipment operates most satisfactorily when stationary, but where the terrain is smooth, operation in motion on a one-way reversible basis is possible. In addition, provision has been made to operate the teletypewriter equipment from a remote position.

N. Alpeth Cable is commercial, paper insulated, telephone cable employing a layer of corrugated, longitudinally-overlapped aluminum foil followed by an extrusion of black polyethylene as jacket construction in place of the conventional lead sheath.

O. Coaxial Cable RG-90/U is a tactical form of single tube coaxial structure for multichannel carrier and video signal transmission. It employs a solid polyethylene insulation over a central copper conductor, followed by three special metallic braids and a low temperature plastic jacket.

P. 5 Pair and 26 Pair Cables are tactical forms of multi-pair communication cables. They are composed of twisted pairs of rubber-insulated copper conductors cabled together and jacketed with a thick sheath of Buna-S compound.

Q. Cable Assembly CX-162/G is a 1000 ft length of 5 pair cable terminated at each end in a quick coupling, waterproof, universal type connector for rapid field installations.

R. Spiral-Four Cable is a tactical form of single quad cable used as transmission facility for four and twelve channel tactical carrier systems. Its four polyethylene-insulated conductors are arranged in a star quad formation with precision electrical balance, followed by a polyethylene belt, stainless steel braid and low temperature plastic jacket.

S. Cable Assembly CX-1065/G is a one-quarter mile length of Spiral Four Cable terminated at each end in a quick coupling, waterproof, universal type connector for rapid field installations.

T. Wire WD-1/TT is a lightweight, twisted pair, tactical field wire for general purpose communications applications. The wire is composed of two conductors twisted together. Each conductor is composed of

four copper and three steel strands concentrically arranged, insulated with polyethylene, and jacketed with a thin nylon sheath.

U. 104 Copper Steel Wire is a "Copperweld" type wire, 0.104 in. in diameter and used in serial suspension for open wire communication applications.

V. Messenger Wire W-115 is a galvanized steel stranded wire, with a 6000 lb rated strength used for supporting cable in aerial suspension.

W. Lashing Wire is a 0.045 in. diameter stainless steel wire used for lashing or attaching a cable to its messenger or supporting wire.

X. Microphone M-29 is a tactical microphone, hand held, using a carbon button, and containing noise cancelling features.

Y. Loudspeaker LS-103/TIQ-2 is a tactical loudspeaker with reentrant horn having a 25 watt rated output.

Z. Handset H-33/U is a tactical, telephone type handset, having a carbon button and used with the Standardized Series Radios.

AA. Headset H-16/U is a tactical, dual receiver headset with metal backed cushions for use under helmets by armored forces personnel.

BB. Headset HS-30 is a miniature headset using dual receivers with molded rubber earphones.

CC. Telephone EE-8 is a tactical field telephone with hand-set, batteries, and circuit elements self-contained in a leather or canvas carrying case.

DD. Telephone TP-6 is a desk-type telephone similar to common commercial models.

EE. Terminal Strip TM-184 is a tactical terminating strip consisting of 28 binding posts mounted on a laminated phenolic strip. It is used as a terminating or test point in tactical field wire systems.

FF. Switchboard SB-22/PT is a small, lightweight tactical switchboard for circuit switching of field telephone traffic. It provides operator attended service for twelve telephone lines.

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89 Commanding Officer, U.S. Naval Medical Research Inst., National Naval Medical Center, Bethesda 14, Md.
90 Director, Naval Air Experimental Station, Air Material Center, U.S. Naval Base, Philadelphia, Penn.
91 Director, U.S. Naval Research Laboratory, Washington 25, D.C. ATTN: Mrs. Katherine H. Cass

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92 Commanding Officer and Director, U.S. Navy Electronics Laboratory, San Diego 52, Calif. ATTN: Code 4223
93-94 Commanding Officer, U.S. Naval Radiological Defense Laboratory, San Francisco 24, Calif. ATTN: Technical Information Division
95 Commanding Officer and Director, David W. Taylor Model Basin, Washington 7, D.C. ATTN: Library
96 Commander, U.S. Naval Air Development Center, Johnsville, Pa.
97-103 Technical Information Service Extension, Oak Ridge, Tenn. (Surplus)

AIR FORCE ACTIVITIES

104 Asst. for Atomic Energy, Headquarters, USAF, Washington 25, D.C. ATTN: DCS/O
105 Director of Operations, Headquarters, USAF, Washington 25, D.C. ATTN: Operations Analysis
106 Director of Plans, Headquarters, USAF, Washington 25, D.C. ATTN: War Plans Div.
107 Director of Research and Development, Headquarters, USAF, Washington 25, D.C. ATTN: Combat Components Div.
108-109 Director of Intelligence, Headquarters, USAF, Washington 25, D.C. ATTN: AFOIN-IB2
110 The Surgeon General, Headquarters, USAF, Washington 25, D.C. ATTN: Bio. Def. Br., Pre. Med. Div.
111 Deputy Chief of Staff, Intelligence, Headquarters, U.S. Air Forces Europe, APO 633, New York, N.Y. ATTN: Directorate of Air Targets
112 Commander, 497th Reconnaissance Technical Squadron (Augmented), APO 633, New York, N.Y.
113 Commander, Far East Air Forces, APO 925, San Francisco, Calif.
114 Commander-in-Chief, Strategic Air Command, Offutt Air Force Base, Omaha, Nebraska. ATTN: Special Weapons Branch, Inspector Div., Inspector General
115 Commander, Tactical Air Command, Langley AFB, Va. ATTN: Documents Security Branch
116 Commander, Air Defense Command, Ent AFB, Colo.
117-118 Commander, Wright Air Development Center, Wright-Patterson AFB, Dayton, O. ATTN: WCRRN, Blast Effects Research
119 Commander, Air Training Command, Scott AFB, Belleville, Ill. ATTN: DCS/O GTP
120 Assistant Chief of Staff, Installations, Headquarters, USAF, Washington 25, D.C. ATTN: AFCIE-E
121 Commander, Air Research and Development Command, PO Box 1395, Baltimore, Md. ATTN: RDDN
122 Commander, Air Proving Ground Command, Eglin AFB, Fla. ATTN: Adj./Tech. Report Branch
123-124 Director, Air University Library, Maxwell AFB, Ala.
125-132 Commander, Flying Training Air Force, Waco, Tex. ATTN: Director of Observer Training
133 Commander, Crew Training Air Force, Randolph Field, Tex. ATTN: 2GTS, DCS/O
134 Commander, Headquarters, Technical Training Air Force, Gulfport, Miss. ATTN: TA&D
135-136 Commandant, Air Force School of Aviation Medicine, Randolph AFB, Tex.
137-142 Commander, Wright Air Development Center, Wright-Patterson AFB, Dayton, O. ATTN: WCOSI
143-144 Commander, Air Force Cambridge Research Center, LG Hanscom Field, Bedford, Mass. ATTN: CRQST-2
145-147 Commander, Air Force Special Weapons Center, Kirtland AFB, N. Mex. ATTN: Library
148 Commandant, USAF Institute of Technology, Wright-Patterson AFB, Dayton, O. ATTN: Resident College
149 Commander, Lowry AFB, Denver, Colo. ATTN: Department of Armament Training
150 Commander, 1009th Special Weapons Squadron, Headquarters, USAF, Washington 25, D.C.
151-152 The RAND Corporation, 1700 Main Street, Santa Monica, Calif. ATTN: Nuclear Energy Division
153 Commander, Second Air Force, Barksdale AFB, Louisiana. ATTN: Operations Analysis Office
154 Commander, Eighth Air Force, Westover AFB, Mass. ATTN: Operations Analysis Office
155 Commander, Fifteenth Air Force, March AFB, Calif. ATTN: Operations Analysis Office
156-162 Technical Information Service Extension, Oak Ridge, Tenn. (Surplus)

OTHER DEPARTMENT OF DEFENSE ACTIVITIES

163 Asst. Secretary of Defense, Research and Development, D/D, Washington 25, D.C. ATTN: Tech. Library
164 U.S. Documents Officer, Office of the U.S. National Military Representative, SHAPE, APO 55, New York, N.Y.
165 Director, Weapons Systems Evaluation Group, OSD, Rm 2E1006, Pentagon, Washington 25, D.C.
166 Armed Services Explosives Safety Board, D/D, Building T-7, Gravelly Point, Washington 25, D.C.
167 Commandant, Armed Forces Staff College, Norfolk 11, Va. ATTN: Secretary
168-173 Commanding General, Field Command, Armed Forces Special Weapons Project, PO Box 5100, Albuquerque, N. Mex.
174-175 Commanding General, Field Command, Armed Forces, Special Weapons Project, PO Box 5100, Albuquerque, N. Mex. ATTN: Technical Training Group
176-184 Chief, Armed Forces Special Weapons Project, Washington 25, D.C. ATTN: Documents Library Branch
185 Office of the Technical Director, Directorate of Effects Tests, Field Command, AFSWP, PO Box 577, Menlo Park, Calif. ATTN: Dr. E. B. Doll
186-192 Technical Information Service Extension, Oak Ridge, Tenn. (Surplus)

ATOMIC ENERGY COMMISSION ACTIVITIES

193-195 U.S. Atomic Energy Commission, Classified Technical Library, 1901 Constitution Ave., Washington 25, D.C. ATTN: Mrs. J. M. O'Leary (For DMA)
196-197 Los Alamos Scientific Laboratory, Report Library, PO Box 1663, Los Alamos, N. Mex. ATTN: Helen Redman
198-202 Sandia Corporation, Classified Document Division, Sandia Base, Albuquerque, N. Mex. ATTN: Martin Lucero
203-205 University of California Radiation Laboratory, PO Box 808, Livermore, Calif. ATTN: Margaret Edlund
206 Weapon Data Section, Technical Information Service Extension, Oak Ridge, Tenn.
207-245 Technical Information Service Extension, Oak Ridge, Tenn. (Surplus)

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